Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

A281.9
R313A
43-51
Cop-1

Watershed Program Evaluation

SIX MILE CREEK, ARKANSAS

interim progress report

ARS 43-51

U.S. DEPARTMENT OF AGRICULTURE
LIBRARY
JUN 1 1959
BELTSVILLE BRANCH

AGRICULTURAL RESEARCH SERVICE
SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

JULY 1957

WATERSHED PROGRAM EVALUATION

SIX MILE CREEK, ARKANSAS

Interim Progress Report

SOIL CONSERVATION SERVICE

Donald A. Williams
Administrator

Hollis R. Williams
State Conservationist for Arkansas

AGRICULTURAL RESEARCH SERVICE

Byron T. Shaw
Administrator

Carl P. Heisig
Director, Farm Economics
Research Division

ACKNOWLEDGMENT

This report is the result of the joint efforts of the Arkansas State Conservationist's Office and the Engineering and Watershed Planning Unit, Fort Worth, Tex., of the Soil Conservation Service, and the Farm Economics Research Division of the Agricultural Research Service.

This report was prepared under the supervision of Elco L. Greenshields, Farm Economics Research Division, ARS, Leslie B. Adkinson, Engineering and Watershed Planning Unit, Fort Worth, Tex., and Dee R. Eoff, Watershed Planning Party Economist for Arkansas, SCS. Nathan G. Mallett, SCS Agricultural Economist, stationed at Paris, Ark., was responsible for the collection of all field data and for compilation and analysis of statistics. William J. Mannlein and Jimmie J. Gigoux, Agricultural Economists, Farm Economics Research Division, ARS, assisted in gathering schedule information from cooperating farm owners and operators.

CONTENTS

	Page
SUMMARY	1
INTRODUCTION	2
THE PROGRAM FOR FLOOD PROTECTION	3
LOCAL CONTRIBUTION AND COOPERATION	9
PROGRESS TOWARD COMPLETION OF PROGRAM	12
Structural measures	12
Land-treatment measures	15
Expected cost for completion of program	17
PURPOSE AND PLAN OF EVALUATION	17
Objectives and limitations of evaluation	17
Hydrologic and sedimentation measurements	18
Recording rainfall and streamflow data	20
Economic inventory of watershed conditions prior to program	26
Changes in land use, management, and production in sample areas	28
Floodwater and sediment damage measurement	29
Land and water management in pool areas	29
Detailed farm cost and return data	30
REDUCTION IN FLOODWATER AND SEDIMENT DAMAGE	30
LAND AND WATER UTILIZATION	42
Flood-plain lands	42
Uplands	46
Reservoir-site lands	50
Water utilization	53
AGRICULTURAL ECONOMY OF WATERSHED	57
PLANS FOR CONTINUATION OF EVALUATION	65
APPENDIX	66

WATERSHED PROGRAM EVALUATION

SIX MILE CREEK, ARKANSAS

Interim Progress Report

SUMMARY

Installation of the planned flood-prevention structures in the Six Mile Creek Watershed is now nearly completed. Despite drought conditions that have retarded adoption of land-treatment measures and practices, nearly 80 percent of the original goal has been attained for those features that were scheduled for application during the first 3 years of the installation period. Of the 26 floodwater-retarding structures planned, 23 were completed by the end of 1956. Stream-channel improvement is now assured by contracts for construction on 29.6 miles of channels.

Evaluation of the economic effects of the installed flood-protection measures is being accomplished by measurement of selected physical and economic factors within the watershed and the changes brought about in these factors by application of the program. To accomplish these measurements, the following basic activities have been either completed or are in process.

1. Delineation of ownership and operating unit boundaries within the watershed.

2. Interviews of all farm operators to obtain the general situation of the agricultural economy in the watershed and to obtain the level of farm income at start of program.

3. Annual surveys of use, management, and production of selected fields in sample areas to establish an inventory of pre-project conditions and to provide progressive measurements of changes.

4. Annual detailed farm-account records of farm production, management, costs, and returns on 15 watershed farms to aid in ascertaining the impacts of the watershed program on farm operations.

5. Survey of land and water management in pool areas of the floodwater-retarding structures to determine their on-site economic effects.

6. Continuous records of precipitation, runoff, and sedimentation at designated points in the watershed.

7. Appraisal of flood and sediment damages from selected floods that occur during the period of evaluation.

Data obtained by the several activities listed above show that substantial benefits have already resulted. Up to January 1, 1957, damage to crops

and pasture from floodwater was reduced $4,735 and other agricultural and non-agricultural damage was reduced by $2,665, making a total benefit of $7,400 from reduction of floodwater damage. Benefits from prevention of flood-plain scour and deposition of infertile overwash on the flood plain amounted to $395. Indirect damages prevented are estimated to be $755. These benefits are attributed to the operation of 6 floodwater-retarding structures during the storms of February, March, and May of 1955 and 14 floodwater-retarding structures operating in February and April of 1956. Improvement in watershed soil-cover complexes has been insignificant to date and any flood-prevention benefits creditable to such changes are inconsequential.

Records of land management in the flood plains do not reveal at this time any significant intensification of land use because of flood protection provided by the watershed measures. Intensified flood-plain use is not expected until after the lapse of a few years following flood protection.

Uses of water stored in the sediment pools of the 23 floodwater-retarding structures includes fishing, boating, swimming, irrigation, livestock water, and supplementary water supply for the city of Booneville. Owners of the land on which two of the reservoirs are located have leased exclusive fishing rights to private groups at a reported $600 annually. The landowners on whose property the reserve water supplies for Booneville are located will receive $800 annually for this water right.

Increased farm returns from installation of conservation practices have not yet been appraised. Although substantial progress in establishing land-treatment practices is indicated, a basis for comparison of farm production with and without improvements has not been established. Methods of developing a base for estimating benefits of this type will require the collection and analysis of field data over a longer period of years.

No appraisal of erosion losses has been made to date because of the minor change that has taken place in soil-cover conditions.

INTRODUCTION

The Six Mile Creek Watershed Protection Project is being carried out under the authority of the Soil Conservation Act of 1935 (Public Law 46, 74th Congress) as implemented by the watershed-protection item in the United States Department of Agriculture Appropriation Act of 1954. This act provided an initial appropriation of $5,100,000 and authorized $30,000,000 for pilot watersheds in a limited number of small stream areas that represent a wide range of problems. The program, which was a forerunner to the Watershed Protection and Flood Prevention Act, Public Law 566 passed by the 83rd Congress, 2d Session, and amended by Public Law 1018, 84th Congress, 2d Session, was initiated to demonstrate the practicability of complete watershed protection as a method of conserving soil and water resources and alleviating damage from floods, siltation of reservoirs, impairment of stream channels, and related problems.

Evaluation studies are being made of the pilot watershed projects to determine the costs and benefits of the installed measures. The broad objectives of these evaluations, as set forth by the Administrator of the Soil Conservation Service, are to determine the effects of the program on:

1. Reduction of erosion and sedimentation and the resultant benefits to farm owners and operators and other interests.

2. Retardation of runoff and the resultant benefits to farm owners and operators and other interests.

3. The economy of the area.

In keeping with resources available for evaluation, intensive surveys were limited to seven projects, and more general investigations were planned for the remaining pilot watershed projects. Six Mile Creek Watershed in Arkansas was selected for intensive study. Six Mile Creek, which is a tributary of the Arkansas River, drains a watershed of 164,627 acres situated in Franklin and Logan Counties in west-central Arkansas. A work plan for watershed improvement was developed in 1954 and installation of the proposed measures was begun in the same year.

THE PROGRAM FOR FLOOD PROTECTION

Estimated watershed requirements for conservation measures that contribute directly to flood prevention were set forth in the Work Plan for Six Mile Creek Watershed, August 1954. Recommended improvements were developed by first estimating the land-treatment measures needed to provide a reasonable degree of soil-erosion prevention and runoff retardation. Included in this group of measures are contour farming, cover cropping, diversions, pasture seeding, ponds, terraces, waterway development, fencing of woodlands, pasture improvement, and roadside stabilization. Quantities of these measures needed were developed chiefly from existing conservation surveys of lands within the watershed area. New surveys were kept to a minimum. Intensified farm planning assistance, which was begun as part of the watershed-protection program, will provide a basis for determining more specifically field-by-field requirements. After the reduction in flood and sediment damages expected to accrue with land treatment was computed, other flood-prevention measures were considered. Measures in this group include floodwater-retarding structures, stream-channel improvement, and tree planting for stabilization of critical runoff and sediment producing areas. The quantity and location of these measures were based on an economic evaluation of the costs and benefits of each measure considered. No separable functioning measure or group of measures was included unless the anticipated benefits exceeded the estimated costs.

Watershed improvements contemplated in the work plan for installation over a 5-year period are shown in table 1. These measures are in addition to those that were already applied when the watershed program was formulated.

Table 1. - Estimated kind, quantity, and cost of watershed improvements required for flood protection, Six Mile Creek Watershed, Ark. 1/

Improvement measure	Unit	Quantity	Estimated cost			
			Federal	Non-Federal public	Private 2/	Total
			Dollars	Dollars	Dollars	Dollars
Land treatment:						
Cover cropping	Acre	12,355	---	---	80,308	80,308
Terracing	Mile	16	---	---	2,800	2,800
Diversions	do.	26	---	---	7,150	7,150
Waterways	Acre	92	---	---	5,980	5,980
Land clearing (new pasture)	do.	2,140	---	---	74,900	74,900
Pasture seeding	do.	32,836	---	---	419,593	419,593
Range improvement	do.	45,337	---	---	253,659	253,659
Revegetation	do.	418	---	---	31,350	31,350
Ponds	Number	441	---	---	99,225	99,225
Stockwater development	do.	19	---	---	1,900	1,900
Tree planting:						
Private land	Acre	494	---	---	9,580	9,580
National forest	do.	507	11,293	---	---	11,293
Fencing	Mile	19	---	---	4,940	4,940
Forest fire control	Acre	54,000	---	1,620	---	1,620
Roadside erosion control 3/	Mile	20.7	4,805	---	---	4,805
Technical services:						
Farm planning and application	Acre	41,212	60,187	---	---	60,187
National forest land	do.	17,162	7,833	2,100	---	9,933
Total			84,118	3,720	991,385	1,079,223
Structural measures:						
Floodwater-retarding structures	Each	26	1,486,341	4/12,244	5/63,783	1,562,368
Stream-channel improvement	Mile	29.6	376,354	4/3,050	5/1,500	380,904
Revegetation of critical areas	Acre	371	10,353	100	2,250	12,703
Total			1,873,048	15,394	67,533	1,955,975
Grand total			1,957,166	19,114	1,058,918	3,035,198

1/ Six Mile Creek Watershed Work Plan, table 1 revised as of February 1, 1957.
2/ Includes an estimated $54,375 in ACPS Federal payments.
3/ National forest roads.
4/ Relocation of roads, bridges, and powerlines.
5/ Value of land easements and rights-of-way.

The recommended improvements do not include certain measures needed for a complete watershed program such as improvement in fishponds and wildlife areas, land drainage, and improvement in timber stands. These types of measures were not included because they have no demonstrable effect on runoff or erosion.

The major planned land-treatment practice included the development and improvement of 87,750 acres of grassland (about 62 percent of all land in farms) that does not have adequate cover. Of this acreage, 11,450 acres of idle cropland was planned for development into new pasture. It would require seedbed preparation, seeding or sodding to base grasses, fertilizing, liming in most instances, and overseeding of adapted legumes. More adequate cover on 29,400 acres of pastured grassland was planned through fertilizing, liming in some instances, and overseeding. On the remaining 47,000 acres of grassland that should be improved, eradication of brush and scrub oak on 30,500 acres was indicated as necessary. Fencing of the new pastures was recommended to make it possible to regulate grazing so that native grasses might recuperate. Better distribution of livestock grazing and maintenance of vegetative cover would also be attained through construction of 904 farm ponds and 80 stock-water developments of springs and seeps.

Land-treatment measures for cropland include cover cropping of 19,687 acres, construction of 103 miles of terraces, 42 miles of diversion, and 186 acres of waterways for controlling the runoff from hill areas.

Tree planting was planned on 1,966 acres of old fields, 1,104 acres of sparsely stocked farm woodland, and 425 acres in the national forest located in the Short Mountain Creek Subwatershed. The plan called for adequate fire protection on about 54,000 acres of forest land, chiefly farm woodland, to the extent that, so far as possible, average annual burn would be less than 1 percent of the protected area.

Although they are not included as a part of the approved watershed program, landowners will be encouraged to apply other land-treatment practices applicable to the watershed. These would include 1,250 acres of wildlife-area improvement and farm drainage on 13,500 acres.

A system of 26 floodwater-retarding structures was planned for installation within the watersheds of Six Mile Creek and Hurricane Creek tributaries. No waterflow-control structures were planned on Short Mountain Creek as the flood damage on this tributary is not great enough to warrant their construction. The small amount of flood damage on Short Mountain Creek is due partly to the good hydrological condition of national forest lands, partly to protection now provided by Cove Lake (152 surface acres), which was constructed in 1938, and City Lake (190 surface acres), which was constructed in 1940, and partly to a diversion channel constructed by the Corps of Engineers in 1948. 1/

1/ Construction was completed during 1948 on a levee across Six Mile Creek 12.2 miles above its confluence with the Arkansas River and a channel was built which diverted the creek into its present outlet into the river. The work was financed with Federal funds under the supervision of the Corps of Engineers, with rights-of-way and maintenance furnished by the McLean Bottom Levee District No. 3.

The planned floodwater-retarding structures will retard runoff from 44 percent of the Six Mile Creek Watershed, excluding the drainage area of Short Mountain Creek. The planned detention capacity of the structures is equivalent to 4.5 inches of runoff from the drainage areas above 25 structures and 5.1 inches above 1 structure. A total of 22,867 acre-feet of capacity will be provided. Of this, 2,754 acre-feet are intended for sediment and the rest for water detention. This amount of detention will make possible the use of vegetated spillways, and will thus effect a substantial reduction in cost over spillways of concrete or similar materials. The surface area at the top of the sediment reserve pools will total 572 acres; and that at the top of the detention pools will total 2,488 acres.

Plans include the improvement of Six Mile Creek channel from the upper end of the diversion channel upstream to the mouth of Caney Creek, a distance of 15.9 stream miles. Seven miles of the Hurricane Creek channel will be improved between its confluence with Six Mile Creek and the mouth of Perry Creek. These improvements will consist mainly of straightening and increasing the capacity of the channel. An estimated 1,839,400 cubic yards of excavation will be needed to improve 22.9 miles of channel.

Approximately 315 acres of gullied, actively eroding abandoned fields, which are a prime source of damaging runoff and sediment and which afford little income or opportunity for effective farm management, are to be planted to trees. Stabilization of such lands in private ownership has proved to be difficult and costly and farmers generally lack the incentive to treat them.

The cost of the program measures set forth in the watershed work plan were estimated at $3,178,482, of which $1,132,483 was to be borne by State and local interests and $2,045,999 by the Federal Government. The quantities of program measures as originally planned, their estimated cost, and the proposed cost-sharing are shown in table 1. The location of the proposed floodwater-retarding structures and the stream-channel improvement is shown in figure 1.

Under the projected land-treatment program contained in the work plan for the Six Mile Creek Watershed Project, $67,382 of watershed funds, in addition to $97,500 expected to be spent under Federal programs now underway, would be required to accelerate the land-treatment measures through increased technical guidance. Under this stepped-up program, assistance to farm owners and operators would not differ from that under the agricultural programs now underway. It was estimated that $54,375 of Agricultural Conservation Program Service funds would be made available during the 5-year installation period to help farmers pay the out-of-pocket expenses involved in installing land-treatment measures.

The Magazine and Franklin County Soil Conservation Districts, under provisions of State enabling legislation, agreed to assume responsibility for overall maintenance and periodic inspection of the floodwater-retarding structures and channel-improvement work. The landowners and operators are expected to maintain the land-treatment measures in accordance with the provisions of the farmer-district cooperative agreements.

Condition of Six Mile Creek channel before improvements were started. Looking upstream from 100 yards below the bridge north of Carbon City. Oil pipeline crosses at this spot. (SCS neg. ARK-62174-A.)

Improved channel of Six Mile Creek at the location in the photograph above. (SCS neg. ARK-62174-B.)

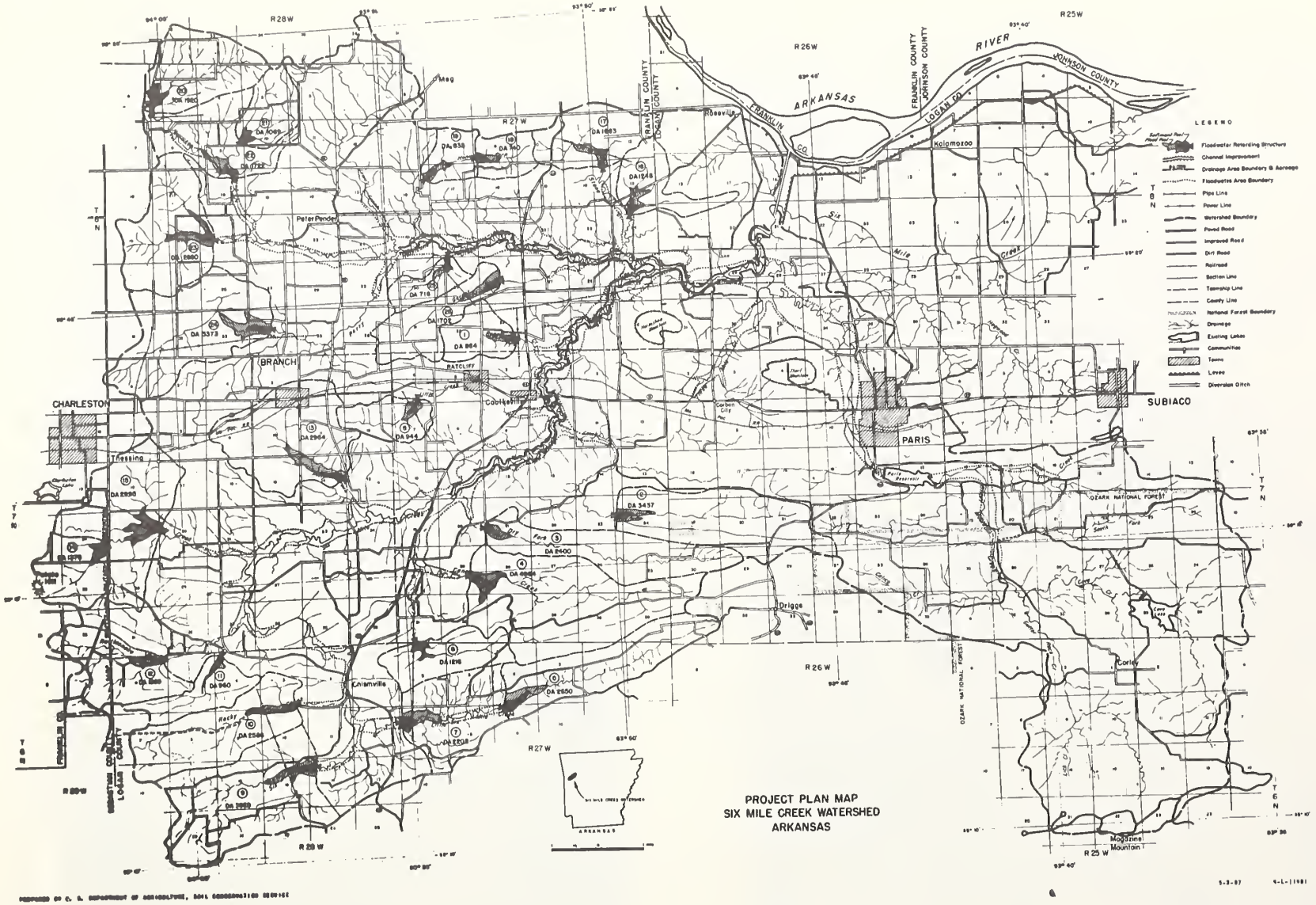

PROJECT PLAN MAP
SIX MILE CREEK WATERSHED
ARKANSAS
LEGEND
Floodwater Retarding Structure
Channel Improvement
Drainage Area Boundary & Acreage
Floodwater Area Boundary
Pipe Line
Power Line
Watershed Boundary
Paved Road
Improved Road
Dirt Road
Railroad
Section Line
Township Line
County Line
National Forest Boundary
Drainage
Existing Lakes
Communities
Towns
Levee
Diversion Ditch
ARKANSAS RIVER
FRANKLIN CO.
LOGAN CO.
JOHNSON COUNTY
FRANKLIN COUNTY
LOGAN COUNTY
CHARLESTON
BRANCH
PARIS
SUBIACO
Kolomozoo
Roseville
Peter Pender
Coulterville
Thessing
Chismville
Drigge
Corley
Magazine Mountain
OZARK NATIONAL FOREST
R 28 W
R 27 W
R 26 W
R 25 W
T 8 N
T 7 N
T 6 N

Figure 1

The watershed works of improvement were planned to provide optimum protection from floods on about 12,000 acres of flood plain. In addition to these effects, land-treatment measures were expected to produce annual conservation benefits of approximately $297,000 accruing from increased net income from crops, pasture, and woodland. Average annual damages based on a 20-year period of record were established as follows:

Damage	Dollars
Crops and pasture	33,995
Other agricultural	4,273
Nonagricultural	4,704
Flood-plain scour	5,604
Overbank deposition	2,120
Reservoir sedimentation	2,120
Indirect	5,282
Total	58,098

The expected reduction in total damages was estimated to be 14 percent by land treatment and 60 percent by structural measures. Reduction in frequency of flooding was expected to permit farm operators to restore some of the bottom land to its former intensity. Benefits of $48,883 annually from this more intensive use would be expected to result entirely from structural measures.

LOCAL CONTRIBUTION AND COOPERATION

The plan of work for the Six Mile Creek Watershed was developed by the joint efforts of the landowners, the Supervisors of the Magazine and Franklin County Soil Conservation Districts, the Soil Conservation Service, the Forest Service, and other participating agencies. As sponsoring agencies, these soil conservation districts incorporated into their respective work plans the program measures or parts of measures that were of direct concern to each. The watershed work plan agreements were made a part of the supplemental memoranda of understanding between the soil conservation districts and the Soil Conservation Service, U. S. Department of Agriculture.

Since the watershed program started, more than 400 farm owners and operators have made agreements with the Magazine and Franklin County Soil Conservation Districts to carry out basic conservation plans, including watershed-protection measures that will provide needed land treatment. The cost to the district supervisors in helping to obtain these individual farm conservation plans is estimated conservatively at $1,000. About 225 farm owners have granted easements and rights-of-way for construction of 24 floodwater-retarding structures and for construction of channel improvement. Construction of the floodwater-retarding dams required 145 separate easements and improvement of the channel required 90 easements. Evidence of interest in the structural program is indicated by one farmer's purchase of 40 acres of land at $1,000 in order to obtain an easement for construction of structure No. 5. The area

conservationist estimates the value of these easements at $65,000, without allowance for the offsetting value of the conservation pools to the landowners who granted the easements.

In accordance with work-plan commitments, the Magazine and Franklin Soil Conservation Districts obtained from landowners the necessary land easements and rights-of-way. Costs of recording easements, which were paid by the local districts, averaged $3.00 per transaction in Logan County and $3.50 in Franklin County. The total expenditure for this purpose was $800. Other costs of acquiring easements borne by the soil conservation district supervisors and others amounted to $9,000. They included transportation costs and telephone calls made in contacting landowners. To obtain one easement, for example, a trip to California, at a total cost of $310, was necessary. Costs of obtaining easements on some of the more involved estates ran as high as $600 and $700.

Working agreements were entered into with the landowners who granted easements. The soil conservation districts set forth the maintenance responsibilities required of each. These agreements provide for technical and other assistance available from the districts for the maintenance of all flood-prevention measures. By the end of 1956, inspection and maintenance of flood-prevention measures had cost farmers $400 and the soil conservation districts $150. As an example of maintenance requirements, one soil conservation district board, consisting of 5 members, spent 1 day in inspecting 5 structures. It is the board's policy to make annual inspections. Interim inspections are to be made by designated representatives of the board.

Logan and Franklin Counties have helped to establish flood-prevention measures by relocating and altering roads and bridges. Relocation of roads was required at sites 4, 9, 13, 16, and 26. The costs of making these required changes have totaled $15,000 to date.

Easements for rights-of-way, including the cost of necessary relocations, granted by utility companies are valued at $7,300. Contributions by utilities included the relocation of electric transmission lines, and relocating, removing, and lowering oil and gas pipelines. Costs involved at a railroad crossing on Six Mile Creek channel consisted of inspection, surveys, and attorney's fees. Raising a high voltage electric transmission line which crossed a detention pool cost a utility company an estimated $1,300.

Civic groups, service clubs, and local businessmen have contributed generously of time and resources to assist with the project. Promotional and educational services furnished by chambers of commerce, local newspapers, and business firms are valued at about $4,400, in addition to financial aid for obtaining easements. One local chamber of commerce group contributed $350 to move a farmer's barn and place a higher foundation under his house in order to raise it above the maximum level of the detention pool of one structure. These groups provided roadside signs in the project area, brochures, news stories, and other services to inform the public of the watershed program. To maintain local interest, one newspaper published in Fort Smith, Ark., carries watershed items periodically.

The Arkansas Game and Fish Commission has furnished and delivered fingerling fish to stock each completed floodwater-retarding structure sediment pool at an estimated total cost of $6,500. This group cooperated in the fish rescue and removal work that resulted from construction operations on the channel-improvement phase of the project. A summary of all local contributions for which a reasonable estimate can be made indicates a total of $103,700 during the first 2 years of the watershed program. These estimates, excluding the actual cost to farmers of applying the various conservation measures, are itemized in table 2.

Table 2. - Estimated value of local contributions, Six Mile Creek Watershed Protection Program, beginning of program to December 31, 1956 1/

Type of contribution	Estimated value	
	Dollars	Dollars
Structural and channel-improvement program:		
Landowner easement:		
Appraised value	65,000	
Recording fees	800	
Cost of acquiring	9,000	74,800
Utility company easements and relocations:		
Electric companies	2,500	
REA lines	2,500	
Gas pipelines	800	
Oil pipelines	1,000	
Railroad crossing	500	
Relocation of roads and bridges	15,000	22,300
Land-treatment program:		
Obtaining landowner conservation-plan agreements:		
Local SC Districts	1,000	
Individuals	600	1,600
Maintenance and inspection of works of improvement:		
Landowners	400	
Local SC Districts	150	550
Promotional contributions:		
Chambers of commerce	1,250	
Local newspapers	1,200	
Local business firms	2,000	4,450
Total		103,700

1/ Excludes costs of installing and maintaining land-treatment measures.

PROGRESS TOWARD COMPLETION OF PROGRAM

Structural Measures

The first contract for structural work in the Six Mile Creek Watershed was awarded on May 26, 1954, and the work order was issued on June 3, 1954. The second contract was let during the remaining days of that month. Work has progressed rapidly because of favorable weather. As of December 31, 1956, the construction phase of the project was well ahead of schedule. As of that date, 23 floodwater-retarding structures had been completed. Easement difficulties have been worked out on one of the 3 remaining floodwater-retarding structures and the contract for construction is in process. A contract was awarded during the latter part of June 1956, for 12.6 miles of channel improvement on the lower part of Six Mile Creek, and since that date contracts have been awarded for the remaining work on the channel.

It has been difficult to obtain easements from landowners to construct some of the planned detention structures. The Board of Supervisors of the Magazine and Franklin County Soil Conservation Districts have done a commendable job in this respect. Because of the newness of the watershed type of program in the area, these men have found it necessary to spend much of their time and, in some instances, personal funds, in order to get agreements executed. Owners of land within the pool areas of the structures in some instances were uncertain as to the possible adverse effects as well as the benefits that would accrue to them. In several instances, structure sites were planned on land that belonged to estates and the heirs were widely scattered. In other situations, structures were planned on land that belonged to persons who resided in other States. Some landowners would not give easements unless they could be provided assurance of water for livestock. Others wanted grazing rights on the spillways and structures sodded to Bermuda grass. To date, easements have been obtained on all except two of the planned structure sites. There is some hope that an agreement can be reached on one of these, but the prospect for the other appears to be dim.

Some of the usual engineering problems found in construction activities of this magnitude were encountered. Soon after work was completed on site 10, some of the rain-soaked shale and sandstone started slumping in the outside spillway cut, which is approximately 30 feet high and on a 1 to 1 slope. Geologists believe that the diversion near the top of the cut will need to be rebuilt farther up the hillside and that this section of the cut must be excavated on a 2 to 1 slope. Following construction of the dam at site 5, a small quantity of clear water seeped around the lower end of the outlet pipe. Upon investigation, it was found that the seepage apparently comes from the sandstone abutments rather than from impounded water in the reservoir. Therefore, no remedial action is necessary.

Despite the general rise in costs of construction, the actual cost of installing the system of structures has not varied significantly from the estimated cost indicated in the work plan. As of December 31, 1956, Federal costs for floodwater-retarding structures amounted to $1,108,116 (table 3).

Flood-retarding structure No. 7, completed October 1954. (SCS neg. ARK-61920-E.)

View of floodwater-retarding structure No. 5, looking west along dam from east side of spillway. (SCS neg. ARK-62000-D.)

Table 3. - Estimated and actual cost of installing floodwater-retarding structures, Six Mile Creek Watershed, Ark.

Structure	Estimated cost			Actual cost			
	Total	Easements and rights-of-way	Construction and other	Total	Easements and rights-of-way	Construction	Other
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
1------	22,718	1,417	21,301	30,185	1,417	28,753	15
2------	118,955	1,520	117,435	91,192	1,520	89,412	260
3------	78,105	953	77,152	59,900	953	58,597	350
4------	68,922	4,074	64,848	102,384	4,074	98,295	15
5------	24,764	956	23,808	28,616	956	27,160	500
6------	57,386	2,849	54,537	46,067	2,849	42,968	250
7------	54,179	4,525	49,654	38,739	4,525	33,939	275
8------	8,323	2,687	5,636	17,598	2,687	13,411	1,500
9------	75,171	4,734	70,437	86,421	4,734	80,987	700
10-----	48,983	1,590	47,393	34,094	1,590	32,054	450
11-----	23,338	645	22,693	26,081	645	25,186	250
12-----	33,171	1,605	31,566	39,480	1,605	37,745	130
13-----	41,192	3,666	37,526	54,028	3,666	50,237	125
14-----	25,860	1,840	24,020	33,354	1,840	31,514	---
16-----	29,086	1,888	27,198	38,823	1,888	36,920	15
17-----	43,027	1,388	41,639	85,697	1,388	82,799	1,510
18-----	20,831	1,200	19,631	33,162	1,200	31,957	5
20-----	24,917	1,148	23,769	56,769	1,148	55,611	10
21-----	57,704	1,026	56,678	83,663	1,026	82,627	10
22-----	19,767	3,100	16,667	55,685	3,100	52,575	10
23-----	30,686	3,540	27,146	47,970	3,540	44,405	25
25-----	12,798	1,112	11,686	30,932	1,112	29,810	10
26-----	35,091	2,362	32,729	43,838	2,362	41,156	320
Total	954,974	49,825	905,149	1,164,678	49,825	1/1,108,116	6,735

1/ Actual figure--sum of column is $2 greater because of rounding figures.

Of the $1,222,913 invested in structural measures up to December 1956, $1,164,678 was used to install the 23 floodwater-retarding structures, now completed, $51,000 to improve an estimated 4 miles of channel, and $7,235 to plant trees on 243 acres of critical runoff and sediment-producing areas. Some of the differences in cost of the completed structures may be explained by changes in the design of structures. The changes in design with respect to size, capacity, and type of spillway are shown in table 4.

Investment in facilities associated with the use and management of water stored in the sediment pools has been inconsequential, except for structures

Table 4. - Design features of floodwater-retarding structures installed, Six Mile Creek Watershed, Ark.

Structure	Work-plan design 1/				Actual construction design				
	Drainage area	Sediment pool	Detention pool	Volume of fill	Drainage area	Sediment pool	Detention pool	Volume of fill	Type of spillway
	Square miles	Acre-feet	Acre-feet	1,000 cubic yards	Square miles	Acre-feet	Acre-feet	1,000 cubic yards	
1-----	1.35	28	324	38.8	1.35	28	324	56.2	Vegetated
2-----	5.37	195	1,267	215.4	5.37	182	1,280	281.8	do.
3-----	3.75	127	906	141.1	3.79	105	903	174.2	do.
4-----	7.76	266	2,108	117.6	7.55	270	2,105	153.7	Rock
5-----	1.90	67	460	43.5	1.85	67	406	56.2	Vegetated
6-----	4.14	226	996	99.8	3.91	232	993	142.1	do.
7-----	3.44	183	821	90.2	3.79	183	821	105.0	do.
8-----	1.47	70	345	6.5	1.57	62	350	9.5	do.
9-----	6.17	295	1,465	128.1	6.22	270	1,490	174.3	do.
10----	4.04	81	969	85.9	4.16	81	1,002	95.7	do.
11----	1.50	32	364	41.4	1.60	32	337	52.1	do.
12----	2.92	74	693	57.8	2.97	62	688	72.9	do.
13----	4.63	186	1,104	64.6	4.30	153	1,041	74.8	do.
14----	2.15	60	515	44.0	2.15	54	516	46.2	do.
16----	1.95	64	654	46.4	1.95	59	468	53.6	do.
17----	2.63	77	455	73.2	2.63	76	631	102.0	Rock
18----	1.16	35	280	35.8	1.16	35	278	42.7	Vegetated
20----	3.00	93	710	41.2	3.00	85	720	52.9	Rock
21----	1.67	43	397	103.8	1.67	43	402	108.9	Vegetated
22----	2.69	84	641	29.8	2.69	73	646	55.4	do.
23----	4.16	88	998	49.1	4.16	90	999	88.0	do.
25----	1.12	25	269	21.2	1.12	25	268	44.7	do.
26----	2.66	54	650	58.4	2.66	55	639	89.0	do.

1/ Work-plan design of spillway was vegetated type for all structures.

7 and 11. In connection with these pools, private funds amounting approximately to $1,700 were used to construct facilities, including sprinkler-irrigation systems. Interviews with affected landowners indicate that substantial investments for irrigation systems, recreational areas, and other purposes are to be made in the near future.

Land-Treatment Measures

Private costs of land-treatment measures, based on cost per unit as used in the work-plan estimates, amounted to $631,155 up to December 31, 1956.

Installation is equivalent to nearly 80 percent of that expected when the project was started. The delay in application of land-treatment measures has been due to many factors, the most important of which were the below-normal rainfall during the last 3 years and the unfavorable cost-price situation that has prevailed. Farmers in the watershed area were reluctant to apply conservation measures, especially the vegetative type, at the high initial costs when moisture conditions were such that there was little likelihood that good results would be obtained.

Federal costs for land-treatment measures up to June 30, 1956, amounted to $94,688. These funds were provided from watershed-program and going-program sources for the following uses:

	Technical services	Installation
Going programs	$47,170	0
Watershed program	31,420	$16,098

All of these watershed program funds that were utilized for installation of land-treatment measures were applied in national forests. Progress in the installation of land-treatment measures is indicated in table 5.

Table 5. - Progress in installation of land-treatment measures, December 31, 1956, Six Mile Creek Watershed, Ark.

Land-treatment measure	Unit	Estimated needs at start of program 1/	Applications reported 1954, 1955, and 1956	Percentage completed
				Percent
Critical area plantings	Acre	371	243	65.5
Cover cropping	do.	12,355	2/15,950	129.1
Terracing	Mile	16	17	106.2
Diversions	do.	26	9	34.6
Waterways	Acre	92	47	51.1
Land clearing	do.	2,140	1,325	61.9
Pasture seeding	do.	32,836	15,778	48.0
Range improvement	do.	45,337	33,594	74.1
Revegetation	do.	418	0	0.0
Ponds	Number	441	232	52.6
Stockwater development	do.	19	10	52.6
Tree planting:				
Private land	Acre	494	286	57.9
National forest	do.	507	304	60.0
Fencing for grazing control	Mile	19	9	47.4
Roadside erosion control	do.	20.7	20.7	100.0

1/ Six Mile Creek Watershed Work Plan, Table 1, revision as of February 1, 1957.

2/ Includes some maintenance plantings of cover crops not separated from "once over" application.

Expected Cost for Completion of Program

The cost of the remaining structural measures to be applied is estimated at $378,840. Of this amount, approximately $115,995 will be needed for floodwater-retarding structures, $259,735 for stream-channel improvement, and $3,110 for planting trees on critical runoff and sediment-producing lands.

The estimate of the cost of the land-treatment measures that are yet to be installed is not as firm as that for the cost of structures. Although efforts at evaluation are aimed toward determining the cost to farmers of applying conservation measures and practices, sufficient information to establish an adequate cost base is not available as yet. Based on work-plan estimates of unit costs and the measures to be applied, the total expenditure required for land treatment would be $1,079,223. About 87 percent of this cost, exclusive of ACPS payments, would be borne by the farmers. Federal costs would include $147,191 for technical services, of which $68,020 are to be provided from watershed funds and $79,171 from programs now underway. Expected Federal costs to be defrayed by watershed funds in the amount of $16,098 will be used for planting trees and controlling roadside erosion in national forests, while $54,375 will be furnished by going programs for conservation payments.

PURPOSE AND PLAN OF EVALUATION

In carrying out the overall evaluation of the Six Mile Creek watershed-protection program, the Soil Conservation Service arranged for the assistance of the U. S. Geological Survey, Weather Bureau, and Farm Economics Research Division, Agricultural Research Service. The local sponsoring agencies and farm operators and owners are furnishing vital information needed in analyzing project results.

Objectives and Limitations of Evaluation

Within the framework of the broad objectives of evaluation stated in the introduction to this report, the plan of study is aimed at appraising the costs and benefits of the flood-protection measures in both physical and economic terms. To make this evaluation, it is necessary to measure various physical and economic factors within the watershed and the changes brought about in these factors by application of the program. This includes an appraisal of changes in runoff, damage from flood and sediment, and production of crops and forage resulting from soil and water conservation improvements. When project benefits are observed and appraised, they are credited, in so far as possible, to the measure or group of measures responsible for their accrual.

Present plans are that the evaluation studies will be continued beyond the fiscal year 1961. Studies over a short period do not provide sufficient observations to permit accurate determination of long-range costs and benefits. Benefits through reduction of flood damages that accrue during the evaluation period will be limited by the number and magnitude of floods and

the rate of installing project measures. Other benefits, such as land enhancement, may not materialize for several years after remedial measures are installed. The general procedure is periodically to observe and appraise the effects of installed improvements as they occur during the study period.

The procedures and techniques of evaluating the anticipated effects of flood-prevention measures that have been developed over a period of years served as a guide in formulating the procedures adopted for the study reported here. The evaluation procedures set forth herein are subject to revision if experience gained in their application should indicate a need for revision.

This evaluation is expected to provide a documentary basis for testing and improving the planning techniques and procedures of estimating probable results from watershed-protection projects. A full analysis of project effects will furnish additional information concerning some of the more hidden impacts of watershed-protection measures. The results of this study, coupled with those of similar studies in other watersheds where different storm characteristics and land problems prevail, will provide a broad basis for appraisal and improvement of the watershed-protection program.

Hydrologic and Sedimentation Measurements

The location of gages and monuments for measuring precipitation, runoff, and sediment are indicated in figure 2. The number and kinds of measuring devices are shown below, along with agency participation in their installation, operation, and maintenance:

Instruments	Installed by	Maintained and operated by
9 recording rain gages	U.S. Weather Bureau and Soil Conservation Service	SCS and WB
45 standard rain gages	WB and SCS	SCS and WB
5 water-stage recorders (stream)	U.S. Geological Survey	USGS and SCS
4 water-stage recorders on structures 2, 5, 6, and 23	SCS	USGS and SCS
39 maximum water-stage gages (stream valley cross sections)	SCS	SCS
Permanent ranges on structures 2, 5, 6, and 23 for sedimentation studies	SCS	SCS

PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

5-3-57 4-8-8153

Figure 2

Within a reasonable length of time after each heavy runoff, the U. S. Geological Survey will make final computations of inflow and outflow for reservoir and streamflow gages and will furnish data on rainfall and runoff to the Soil Conservation Service. An engineering field party will resurvey established sediment ranges to determine the depth of sediment deposition in structures 2, 5, 6, and 23 once each 5 years or more often if necessary. The instruments will provide a record of the storms, the inflow and outflow hydrographs, in four structures, and a record of streamflow for the main stream reaches in which floodwater and sediment damages occur.

Arrangements were made on December 14, 1957, between the USGS and the SCS to establish a trap-efficiency study on floodwater-retarding structure No. 6. The work contemplated will consist of collection of sediment inflow and outflow samples, analysis of the chemical character of inflow water, particle distribution of sediment, determination of sediment concentration in inflow and outflow water, and computation of total sediment discharge in outflow. This information, together with the surveys mentioned for sediment accumulation in structure No. 6, is to be used in determining the trap efficiency of the reservoir.

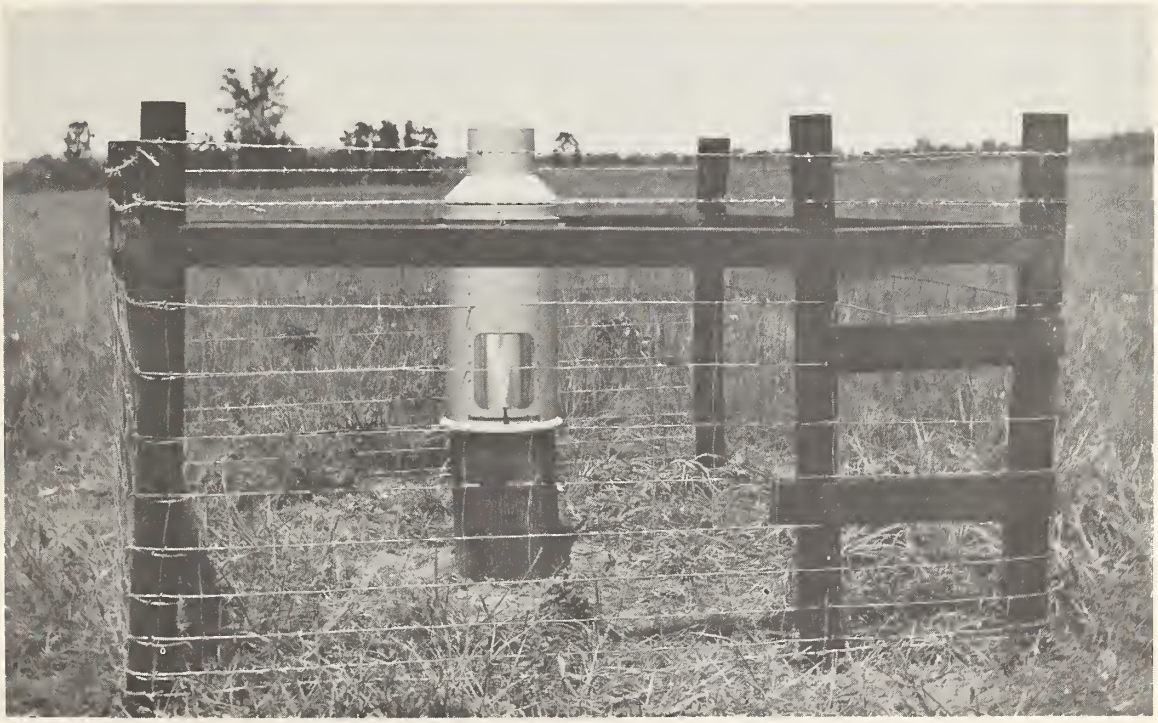
Recording Rainfall and Streamflow Data

Rain gages are read after each rain and the recording gages are checked twice a week, even if there is no rain, in order to insure proper operation. These rainfall data are forwarded to the U. S. Geological Survey Office which in turn submits a quarterly report of rainfall to the Watershed Project Office. For all storms that produce 0.15 inches or more runoff in the Hurricane Creek part of the watershed, or 0.25 inches or more runoff in the rest of the watershed, the U. S. Geological Survey will submit data quarterly on inches of runoff.

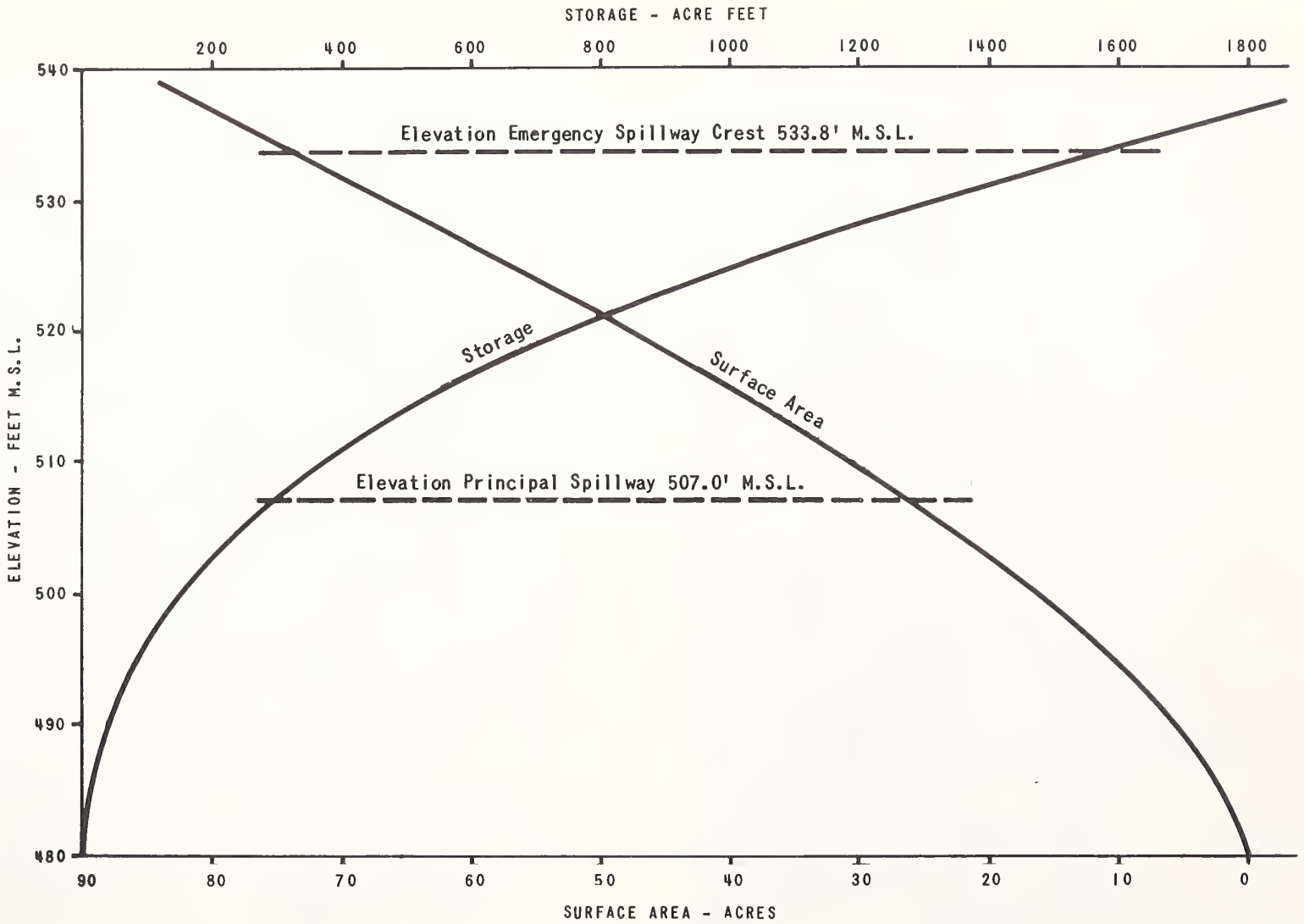
The maximum-stage recorders located at 39 stream-valley cross sections will be read following all flood-producing storms until firm runoff-area inundated relationships have been established. After the accuracy of runoff-area inundation relations has been checked, gage readings at cross sections will be taken only for storms on which special storm reports are to be made. These storms will include storms that would produce enough runoff under preproject conditions to inundate 50 percent or more of the flood plain.

Records of streamflow and flood stages at the 5 stream gages, water levels in structures 2, 5, 6, and 23, and precipitation at 54 locations will be maintained by the U. S. Geological Survey. (See stage-area-capacity curves, figures 3, 4, 5, and 6.) The data are to be summarized and analyzed to permit plotting of the daily pool stage and volume of water in the gaged structures. For cross section number 1 on Hurricane Creek, it has been estimated that under average conditions 0.95 inches of rain will produce 0.14 inches of runoff and that this amount of runoff will produce flows 6 inches above flood stage.

Stream gage located at bridge over Hurricane Creek on Highway 23, 3 miles north of Caulksville. (SCS neg. ARK-62168.)



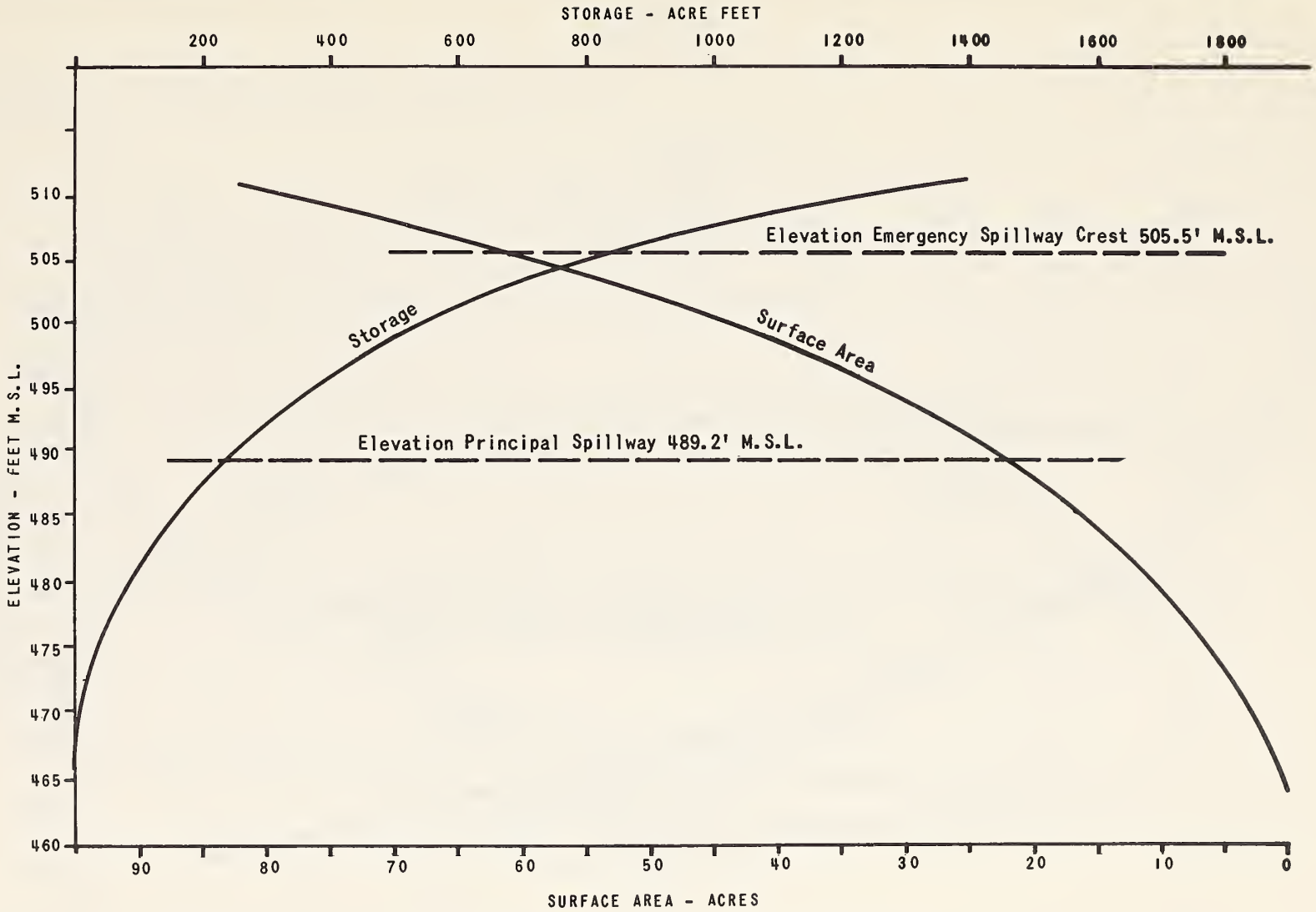
Recorder rain gage No. 3 R located 2 miles east and 4 miles north from Charleston. On October 22, 1954, this gage recorded 8.3 inches of rain. (SCS neg. ARK-61978.)



STAGE-AREA-CAPACITY CURVE
SITE 2

PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE 5-3-57 4-L-11483

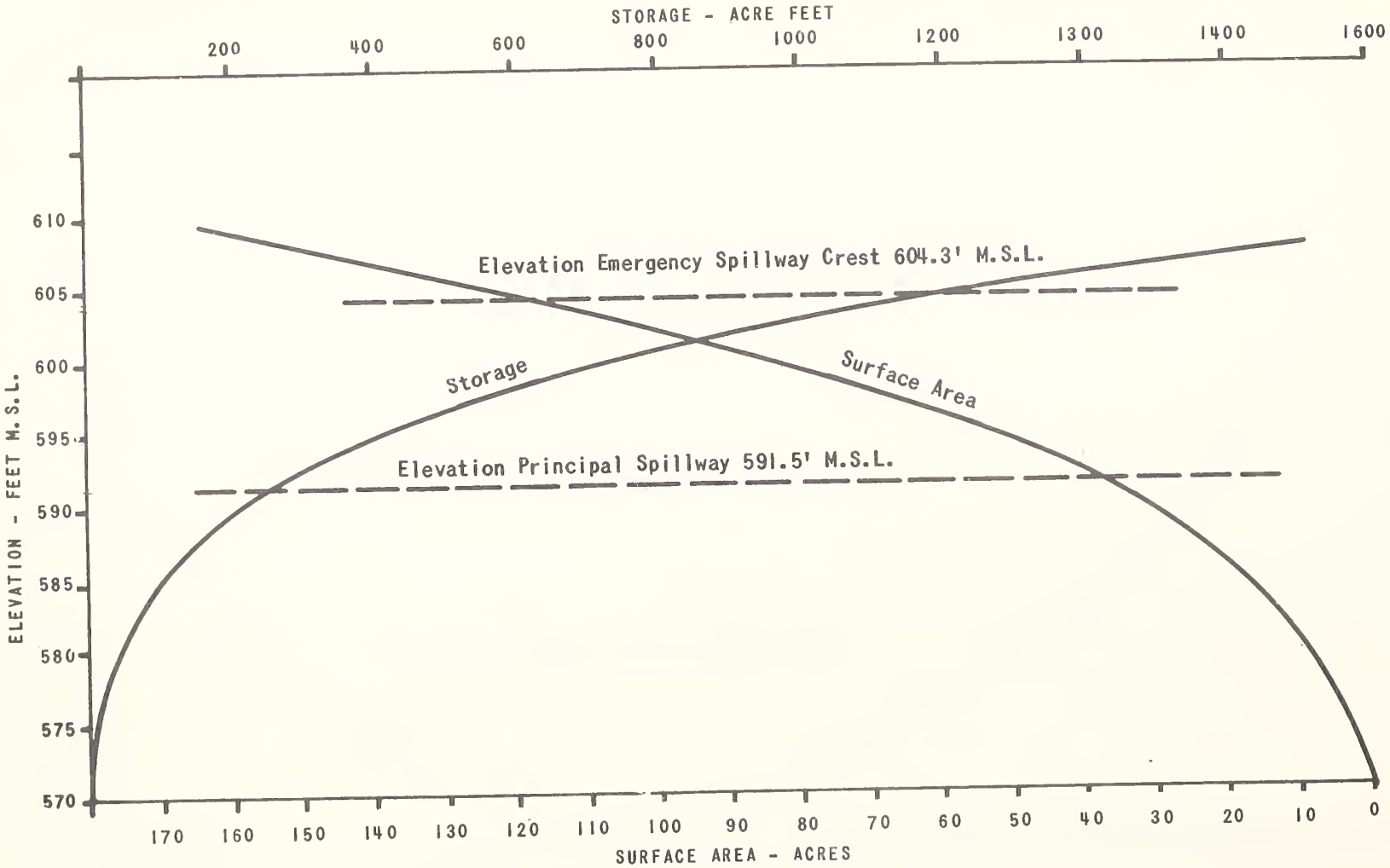
Figure 3



STAGE-AREA-CAPACITY CURVE
SITE 5

PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE 5-3-57 4-L-11484

Figure 4

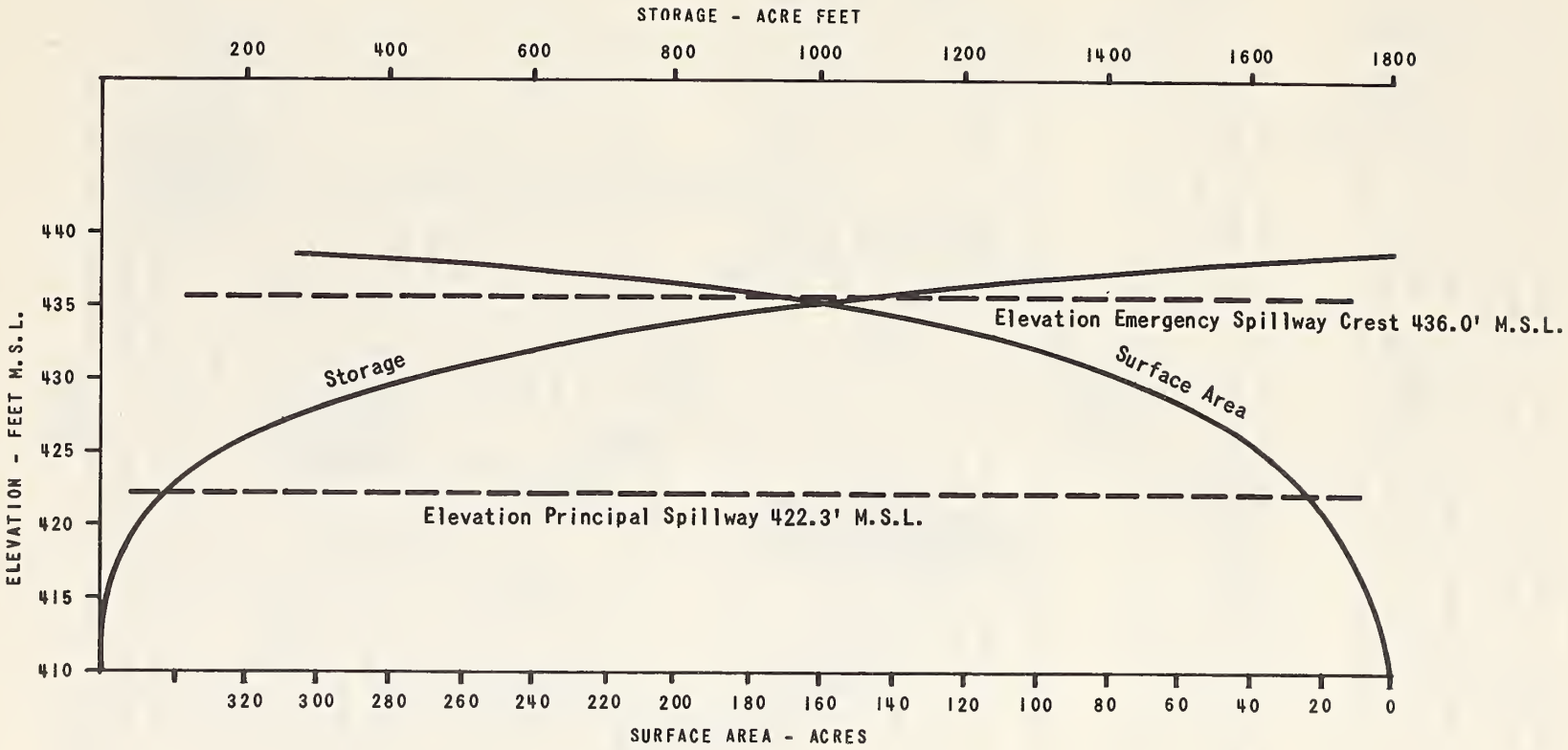


STAGE-AREA-CAPACITY CURVE
SITE 6

PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

5-3-57 4-L-11485

Figure 5



STAGE-AREA-CAPACITY CURVE
SITE 23

PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE 5-3-57 4-L-11486

Figure 6

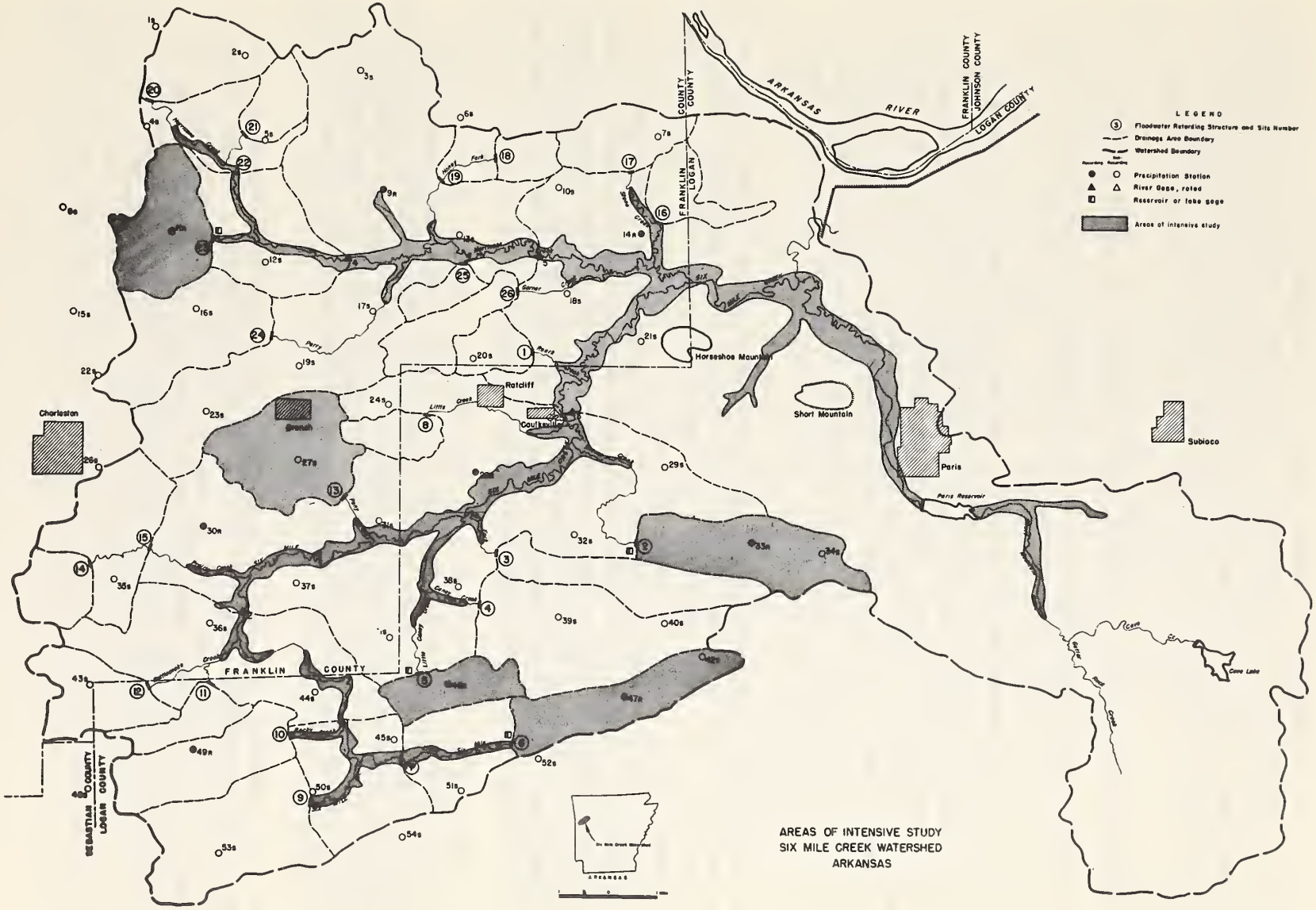
When rainfall and streamflow data have been recorded for a long enough time and cover a sufficient variety of floods, it will be possible to check the accuracy of the rainfall runoff and peak discharge relationships that were used in the work plan. This material, together with records of flood stages obtained from the maximum stage gages and aerial photographs of the flood-plain area inundated, will provide basic data for the following relationships: (1) Stage-discharge curves for each valley cross section; (2) stage-area inundated curves for each valley reach; and (3) inches of runoff versus acres of inundated curves.

The drainage areas above the five stream gages range from 17.1 to 102.0 square miles. Adequate streamflow measurements from these gages will provide runoff relationships useful in planning future watershed-protection projects throughout much of the country. The basic data available will make it possible to check alternate flood-routing procedures as well as other procedures used in watershed evaluation.

Economic Inventory of Watershed Conditions Prior to Program

An inventory of watershed conditions taken prior to installation of the works of improvement will serve as a benchmark for measuring changes in the watershed. Field surveys and analyses of available data from secondary sources were used to map farm ownership and operating unit boundaries of all farms in the watershed. All farm operators, except those in the national forest purchase area, were interviewed to obtain a general situation report of the agricultural economy. Information obtained from this survey includes data on land use, farm tenancy, type and size of farm enterprises, crop and livestock production, gross sales, and off-farm work. This general farm survey will be repeated at the end of 5 years.

Detailed use, management, and production data were obtained for all farm fields in (1) the flood plain, (2) the drainage areas above structures at sites 2, 5, 6, 13, and 23, and (3) for 205 sample fields located one each per square mile within the watershed. These areas of intensive study are shown in figure 7. Sample fields were not taken in the upland area of Short Mountain Creek Subwatershed and the portion of the watershed that lies in the Fort Chaffee area. Of the 42,527 acres in the Short Mountain Creek Watershed, more than 23,000 acres are included in a national forest purchase area. The sample watersheds and fields are representative of watershed conservation problems encountered in the project area. Data collected on selected fields through farmer interviews include land use, yields, fertilizer and conservation practices installed from 1951 to 1954. Hazards, such as drought, flood, hail, and insect infestations, which may have affected yields, were listed also. For those fields or parts of fields that are situated on flood plains, records of past damages from floods were made. The summary and analysis of the information obtained by the field survey are intended to provide the basis for (1) recording changes in production that occur because of measures applied through the watershed protection program, (2) assigning benefits to individual or groups of interdependent measures, and (3) recording before and after land uses and rate of change.



PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

5-8-57 4-L-11687

Figure 7

When the watershed work plan was made, a map of the flood plain was prepared and traced on standard plan-profile paper from 4-inch-to-the-mile aerial photographs. This map shows the flood-plain outline of the area flooded by the 25-year frequency flood. Land use of the flood plain in 1954 is shown in place along with flood-plain cross-section locations, roads, railroads, bridges with area of openings, stream-gage locations, and stream channels.

Changes in Land Use, Management, and Production in Sample Areas

For each of the fields selected in the preproject inventory, an annual record of use, yield, and management practices, including conservation, production, and flood damage, is to be maintained. Damage will be computed for each flood and the average depth of inundation will be noted at points of damage. In addition to this information, an appraisal of flood-plain benefits that result from the effect of improvements installed will utilize measurements of streamflow, flood stage, and inundated areas. This file of annual data, along with data on other available factors, such as weather, will be used in computing the effectiveness of the watershed measures installed. It will provide a partial basis for income analysis on treated and untreated fields and farms, including appraisals of returns from alternative treatments when they are feasible.

The inventory of present management and production on sample fields, together with the annual record of change, will provide a basis for achieving these objectives: (1) More adequate information on present land use and the rate of change after land treatment; (2) reasons for adopting or not adopting land-treatment measures and for maintaining or failing to maintain measures after treatment; (3) yields obtained on treated and untreated areas, by capability classes, soil units, and types of treatment; (4) relationship between flood-free crop yields on various flood-plain soil units; (5) relationship between depth and texture of overbank deposition and yields; and (6) rate of yield recovery after varying degrees of deposition and scour.

For determining the effect of land use and cover conditions on rainfall-runoff relationships, the soil cover complex will be determined periodically for each of the watersheds above the water-stage recorders in reservoirs 2, 5, 6, and 23. If changes are enough to affect infiltration rates materially, determination will be made annually. The changes in the soil cover complex will be obtained from work-unit reports on conservation practices applied and from the annual surveys described previously.

For the watershed as a whole, progress in establishing watershed-protection and flood-prevention measures will be recorded annually. These records will include the quantity and kind of measures installed, together with the costs borne by Federal, non-Federal, public, and private interests. Unit costs of installing and maintaining land-treatment measures are obtained annually by field surveys in the flood plain and on sample areas.

Floodwater and Sediment Damage Measurement

Damages are to be appraised after each significant flood for (1) current flooding at the time of the storm and (2) computed flooding in absence of works of improvement. These appraisals will be the basis for determining benefits from the control measures. When the magnitude of a storm is such that flooding would be produced under preproject conditions but not after the improvement measures are applied, damage without treatment will be estimated on the same basis as was used in preparing the work plan. In making this estimate, adjustments will be required in the damageable values resulting from changes in land use, crop distribution, and yields in the flood plain.

As a physical basis for appraisal of damage, areas actually inundated are to be determined by use of flood-stage records at the several stream-valley cross sections in conjunction with the flood-plain map, which indicates channel and flood-plain profiles. Records obtained from the stream gages, reservoir water-stage recorders, and rain gages will be utilized to determine by stream reaches the areas of flood plain that would have been inundated if the improvements had not been installed.

When actual flooding has occurred, schedules will be used to obtain information on damage from farmers and other property owners affected. Throughout other phases of the evaluation study, management and production of flood-plain fields and other flood-plain data will be accumulated for use in firming up the appraisal of damage.

If significant changes in sediment or erosion damage occur on the flood plain, resurveys will be made of the monumented valley cross sections to ascertain the extent of deposition, scour, and cutting of stream banks. Changes in productivity or in land use caused by damage of this kind will be recorded during the annual field survey of the flood plain. During this survey, deposition damage to other improvements in the flood plain will be enumerated also.

Effects of sediment deposition in floodwater-retarding structures on utilization of the sediment pools and on production of other reservoir lands will be determined by the land and water management survey of pool areas described below. Damages caused by deposition in farm ponds, terrace systems, outlet channels, and other improvements located in the sample fields will be recorded annually.

Land and Water Management in Pool Areas

Special studies are underway in the floodwater-retarding pool areas to obtain information regarding the on-site economic effects of these pools. Preconstruction uses of lands inundated by sediment and detention pools, including costs and returns, have been obtained from Soil Conservation Service records and from operators on whose lands the pools are located. Data of the following types are being assembled annually for each structure:

(1) Use of water in sediment pool; (2) use and management of lands in pool area above sediment-pool elevation related to zones of flood frequency; (3) investment in fixed improvements associated with use of pools; (4) storm and flood damage to structural works; and (5) repair and maintenance of structural works.

Detailed Farm Cost and Return Data

A detailed study of farm production, management, costs, and returns is being made on 15 watershed farms, primarily to aid in ascertaining the impacts of the watershed program on farm operations. A standard farm record book is used to record annually detailed data concerning land use, production, sales, production expenses, numbers of livestock, and conservation practices. These data will be useful in budgeting different conservation practices and combinations thereof for selected farm groups as well as in estimating results for all farms in the watershed.

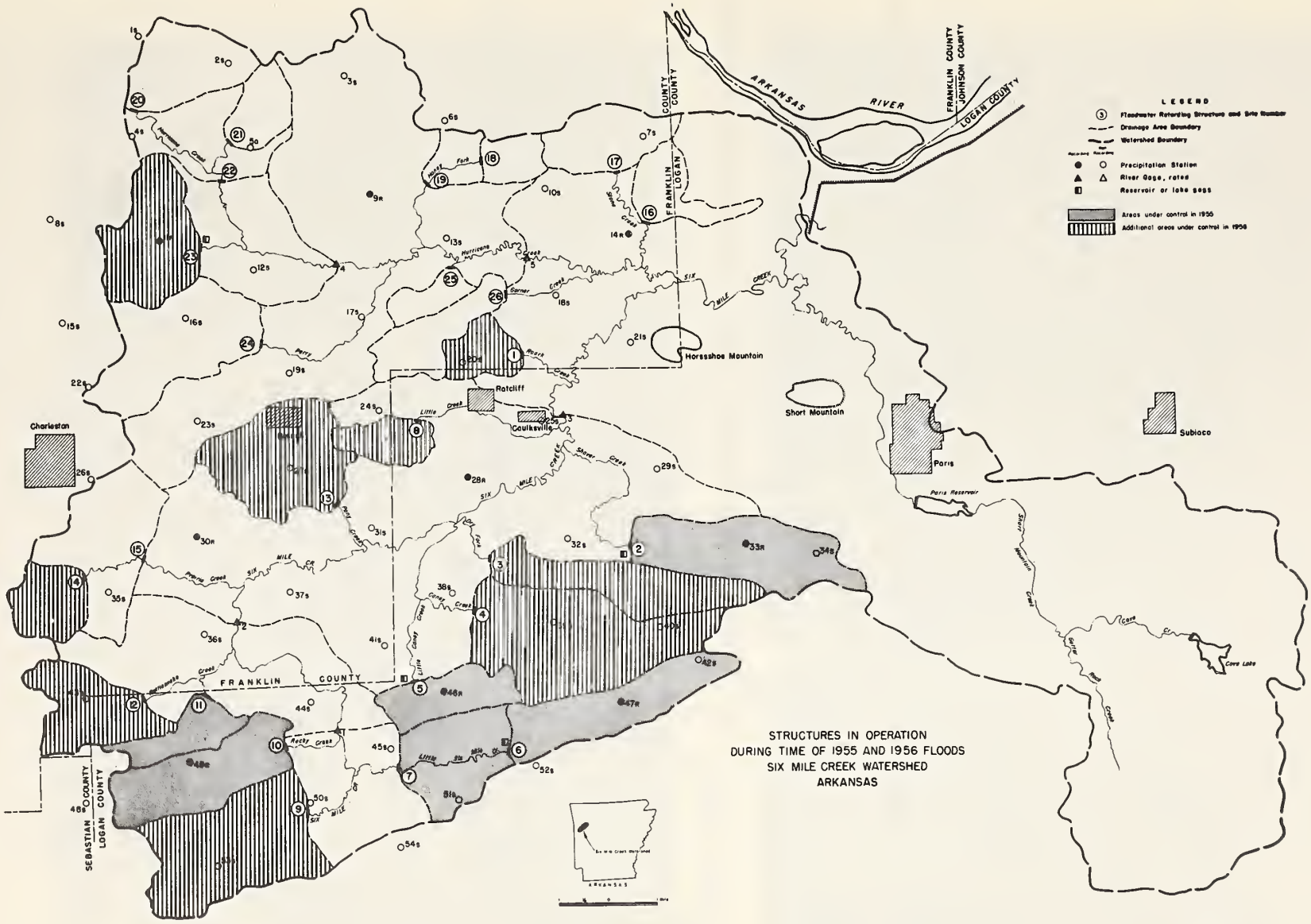
These 15 farms were selected to be as representative as possible of the entire watershed area. All types of farm enterprises carried out in the watershed are represented among the sample farms. Seven of the farms have some flood-plain land. Four have land in the Ouachita Highlands, and the rest are located in the Cherokee Prairie problem area.

REDUCTION IN FLOODWATER AND SEDIMENT DAMAGE

Since construction of the project began, 3 flood-producing storms occurred in 1955 and 3 in 1956. The 1955 storms occurred on February 20, March 20, and May 20. The 1955 floods occurred at a time when 6 floodwater-retarding structures were in operation (fig. 8). These 3 storms inundated 16,015 acres (table 6). Most of the flooding occurred along the mainstem of Six Mile Creek and the mainstem and tributaries of Hurricane Creek. The tributaries of Six Mile Creek were under partial control at the time of the flood-producing storms during 1955.

Preliminary estimates of the effects of detention storage of selected storms indicate that peak discharges at 3 stream-gage locations in Six Mile Creek were reduced as much as 90 percent when 77 percent of the watershed drainage above the gage was under control (table 7). When only 20 percent of the watershed drainage was under control, peak discharges were reduced up to 33 percent. With half of the watershed under control, reduction in peak discharges ranged from 28 to 66 percent for the 3 floods in 1955.

The acreage of land inundated by the floods of February 20 and May 20 was computed from generalized runoff-area-inundated graphs prepared during the development of the work plan. The area inundated by the storm of March 20 was computed by applying recorded stages of the high-water marks produced by the storm to stage-area curves developed for each stream-valley reach. Established relationships between flood stage, peak discharge, and area flooded indicate that if floodwater-retarding structures had not been installed during the 1955 floods, the inundated area would have been 11.5 percent greater.



STRUCTURES IN OPERATION
DURING TIME OF 1955 AND 1956 FLOODS
SIX MILE CREEK WATERSHED
ARKANSAS

PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Figure 8

Table 6. - Effect of installed flood-prevention measures on area inundated by floods of 1955-56, Six Mile Creek Watershed, Ark.

Depth of inundation	Estimates of area flooded		
	With no measures installed	With measures installed at time of flood 1/	Reduction because of installed measures
	Acres	Acres	Acres
All floods, 1955:			
0-1.0 foot	6,565	6,143	422
1.1-3.0 feet	8,122	7,175	947
Over 3.0 feet	3,164	2,697	467
All depths	17,851	16,015	1,836
All floods, 1956:			
0-1.0 foot	4,180	2,720	1,460
1.1-3.0 feet	3,805	2,881	924
Over 3.0 feet	1,322	715	607
All depths	9,307	6,316	2,991
All floods, 1955 - 1956:			
0-1.0 foot	10,745	8,863	1,882
1.1-3.0 feet	11,927	10,056	1,871
Over 3.0 feet	4,486	3,412	1,074
All depths	27,158	22,331	4,827

1/ Six structures effective at time of 1955 floods and 14 structures effective at time of 1956 floods.

Reduction in damage from floodwater and sediment and the computed benefits attributed to flood-prevention measures were determined by using procedures applied in preparing watershed work plans. These procedures, the details of which were outlined in manuals issued by the Fort Worth SCS Engineering and Watershed Planning Unit, involve among other calculations the following:

1. Acreage of different crops and pasture in the flood plain by stream reaches.

2. Average damageable value of each use listed in "1" per acre of flood plain.

3. Percentage of damage to each kind of crop and pasture by flood-depth intervals, by months (or seasons).

Flood on Six Mile Creek following period of heavy rainfall March 13 to 19, 1955. The Arkansas River may be seen in the background. (SCS neg. ARK-62173.)

Flood plain damage on Six Mile Creek at the mouth of Little Creek during storm of March 20, 1955. Two to 4 inches of silt and clay were deposited on this 5-acre cornfield and in small spots sheet scour occurred. About 900 feet of fence washed out and 400 feet were damaged by debris. (SCS neg. ARK-62171.)

Table 7. - Estimated effects of detention storage on streamflow, Six Mile Creek Watershed, Ark., 1955-56

Date of event	Stream gage 1 Drainage area = 14,954 acres			Stream gage 2 Drainage area = 22,749 acres			Stream gage 3 Drainage area = 65,299 acres		
	Recorded peak discharge 1/	Estimated peak discharge without control	Percentage of reduction	Recorded peak discharge 1/	Estimated peak discharge without control	Percentage of reduction	Recorded peak discharge 1/	Estimated peak discharge without control	Percentage of reduction
	Cubic feet per second		Percent	Cubic feet per second		Percent	Cubic feet per second		Percent
	(51% of watershed controlled)			(38% of watershed controlled)			(20% of watershed controlled)		
February 19, 1955	858	2,050	58	1,590	2,520	37	3,780	4,260	11
March 20, 1955 2/	2,810	3,880	28	4,530	4,780	5	8,780	8,960	2
May 20, 1955	316	920	66	489	1,130	57	1,280	1,900	33
	(77% of watershed controlled)			(64% of watershed controlled)			(46% of watershed controlled)		
February 16-17, 1956	218	2,150	90	609	2,640	77	1,800	4,470	60
April 29, 1956 3/	---	---	---	161	1,020	84	568	1,730	67

1/ From unpublished USGS data, subject to revision.

2/ A high-intensity rain falling on saturated soils and following an approximate 2-inch rainfall on March 17, 1955.

3/ Six Mile Creek only.

4. Composite crop and pasture damage rate, per acre flooded, by depth of flooding for each season.

5. Acreage of land inundated to depths of 1 foot or less, 1.1 to 3 feet, and more than 3 feet by flood stage in each stream reach.

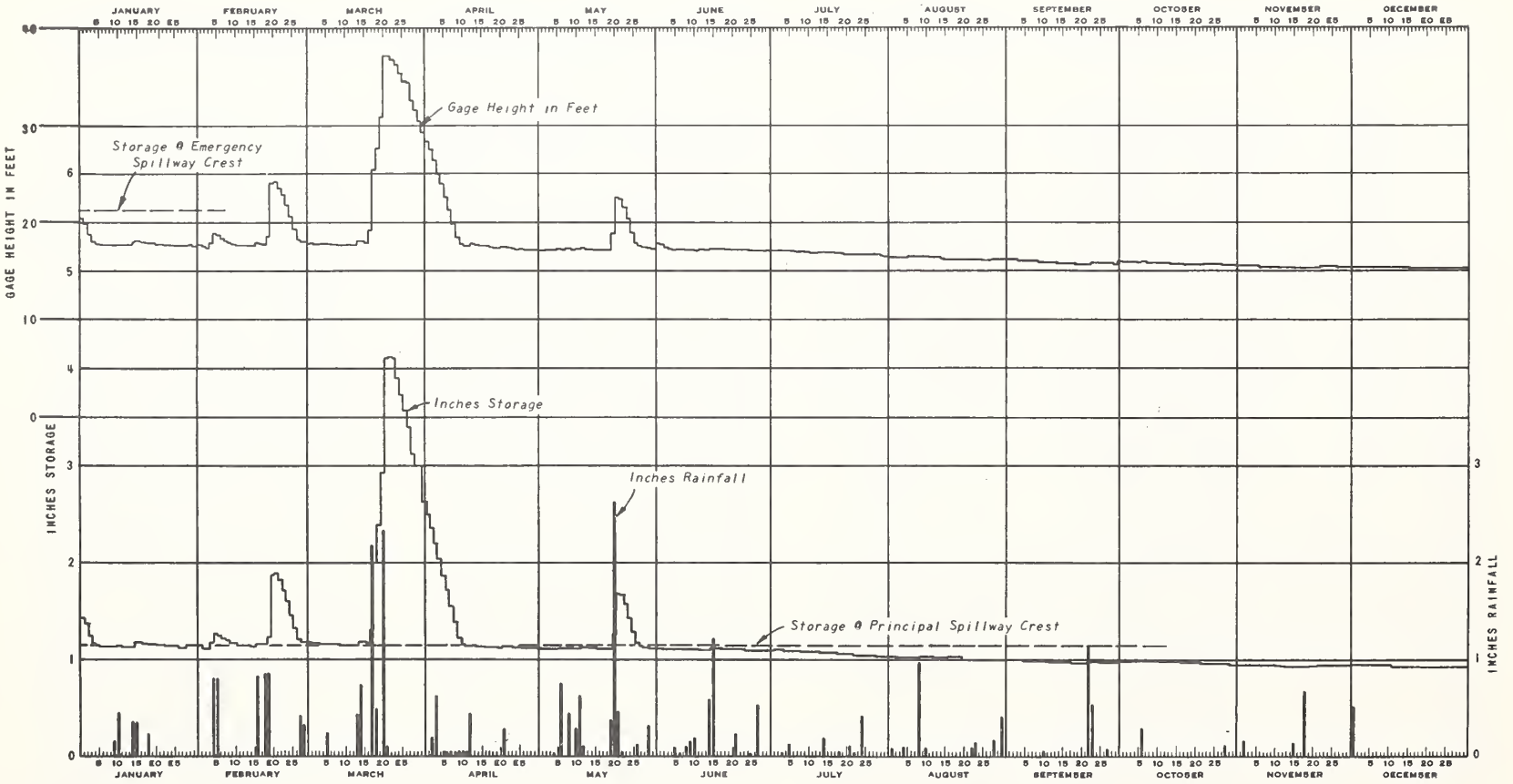
6. Stage-damage curves by season.

Three of the 6 structures that provided control on the 1955 storms are gaged. The operation of these 3 structures is shown in figures 9, 10, and 11. These figures show storage in inches of runoff from the drainage area of each structure. The daily rainfall shown was calculated by the weighting of the recorded rainfall by the Thiessen polygon method at the several rain gages within and near the drainage area of each structure. For example, the daily rainfall for site No. 5 is the polygon weighting of rainfall measured by one recording and 4 standard rain gages.

Maximum peak storage in each of the 3 structures, as shown, occurred on March 22 following the storm of March 20. Maximum storage in structure No. 2 was 4.1 inches. In structures Nos. 5 and 6, storage was 5.3 and 4.5 inches, respectively, of runoff from their respective drainage areas. Minor peak storages occurred on February 22 and on May 21. It will be noted that in structure No. 2, discharge of storage to approximately the drawdown outlet required about 21 days.

The total floodwater and sediment damage caused by the three floods in 1955 was estimated at $13,010 (table 8). In these flood-damage calculations, 1955 prices and land use in the flood plain as determined through the field-by-field survey were used. Flood-free yields were used as determined for preparation of the work-plan estimates, except that a lower oat yield was used because of drought. The damage that would have occurred without any flood-prevention structures or measures installed was estimated at $16,460. This shows a benefit of $3,450 accruing in 1955 as the result of installed works of improvement. All planned structures and land treatment, if they had been installed, would have produced an estimated benefit of $14,510 from reduction of floodwater and sediment damage. Thus installation of all planned flood-prevention measures would have prevented more than 80 percent of the damage from the 1955 floods.

The 3 flood-producing storms of 1956 inundated 6,316 acres (table 9). In the absence of control works, these floods would have inundated 9,307 acres. Actual damage caused by the February 16 to 17 flood was $4,440, by the April 16 flood, $1,110, and the flood of April 29 caused $210 in damage (table 10). In the 1956 estimates of flood damage, the same prices and yields were used as in the 1955 estimates, but the land use was determined for 1956 by field survey. The three 1956 floods would have caused an estimated damage of $10,860 in the absence of any control structures. Thus installed works produced a benefit of $5,100 in floodwater and sediment damage reduction. It is estimated that if all planned watershed protection measures had been installed, they would have produced flood-prevention benefits amounting to $10,495 in 1956.

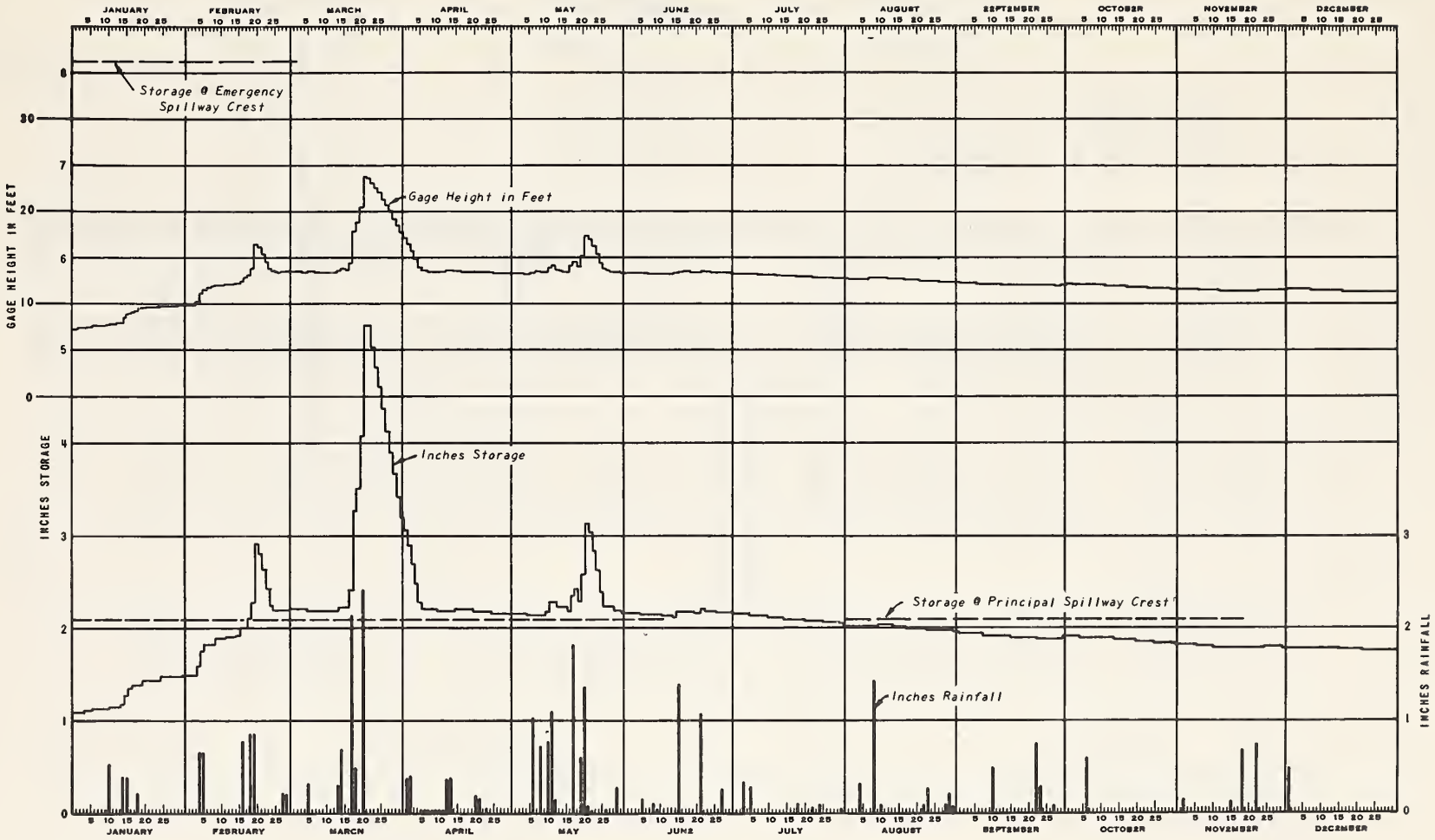


AVERAGE DAILY RAINFALL AND RESERVOIR STORAGE CURVES
FOR CALENDAR YEAR 1955
SITE NO. 2
SIX MILE CREEK WATERSHED
DATA FURNISHED BY U.S.G.S.

PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

5-3-57 4-L-11489

Figure 9

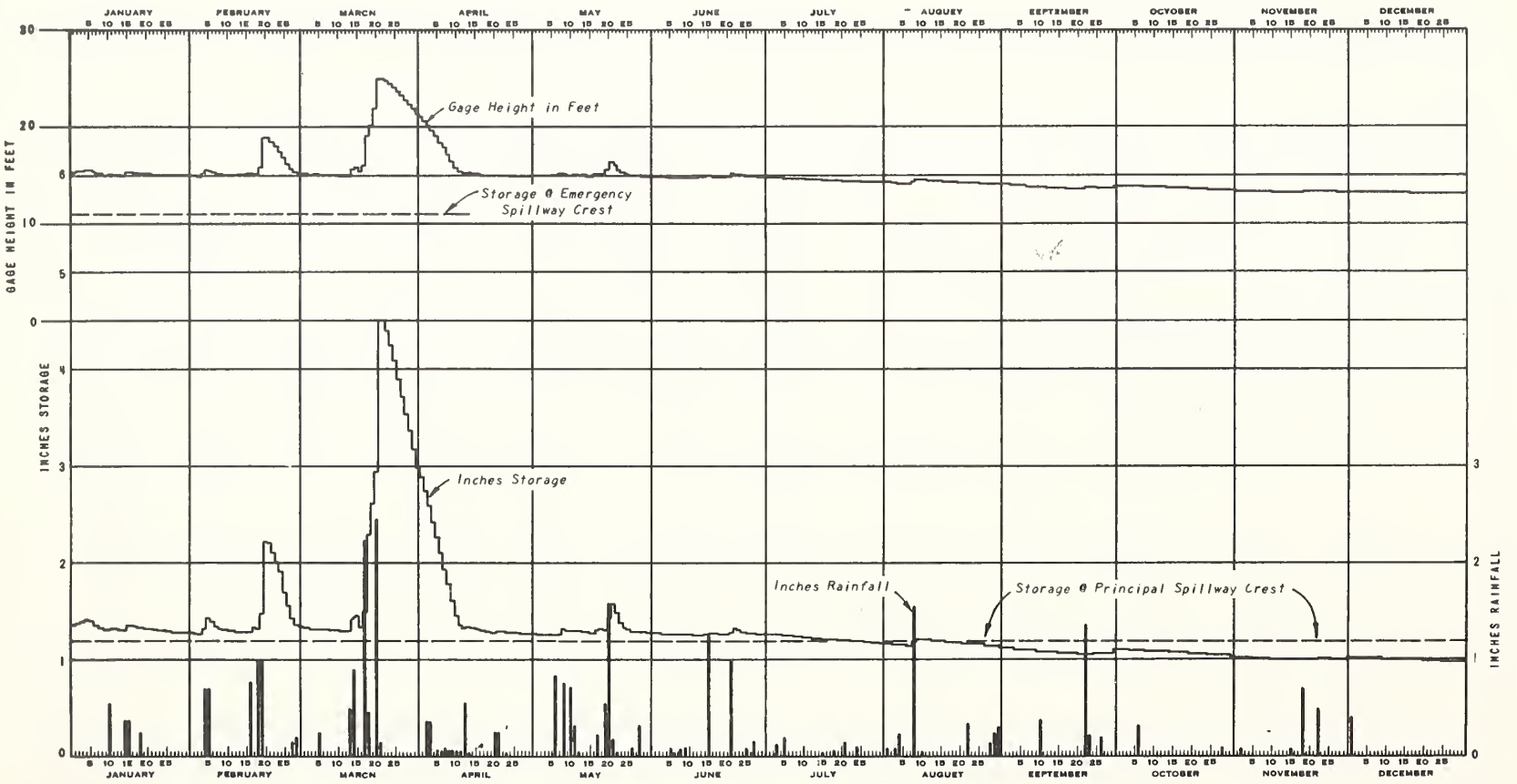


AVERAGE DAILY RAINFALL AND RESERVOIR STORAGE CURVES
FOR CALENDAR YEAR 1955
SITE NO. 5
SIX MILE CREEK WATERSHED
DATA FURNISHED BY U.S.G.S.

PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

5-3-57 4-L-11490

Figure 10



AVERAGE DAILY RAINFALL AND RESERVOIR STORAGE CURVES
FOR CALENDAR YEAR 1955
SITE NO. 6
SIX MILE CREEK WATERSHED
DATA FURNISHED BY U.S.G.S.

PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

5-3-57 4-L-11491

Figure 11

Table 8. - Floodwater and sediment damages and estimated benefits from installation of flood-prevention measures, Six Mile Creek Watershed, Ark.

Type of damage	Actual damage	Estimated damage without flood-prevention measures	Benefits from installed flood-prevention measures	Estimated damage with all planned flood-prevention measures installed	Benefits from installation of all planned flood-prevention measures
	Dollars	Dollars	Dollars	Dollars	Dollars
ALL 1955 FLOODS					
Crops and pasture----	5,740	7,290	1,550	1,260	6,030
Flood-plain scour----	290	370	80	50	320
Other agricultural---	2,910	3,420	510	200	3,220
Nonagricultural------	2,280	3,040	760	50	2,990
Overbank deposition--	670	930	260	230	700
Indirect----------	1,120	1,410	290	160	1,250
Total----------	13,010	16,460	3,450	1,950	14,510
ALL 1956 FLOODS					
Crops and pasture----	3,000	6,185	3,185	285	5,900
Flood-plain scour----	35	75	40	0	75
Other agricultural---	1,030	1,805	775	45	1,760
Nonagricultural------	1,155	1,775	620	0	1,775
Overbank deposition--	15	30	15	0	30
Indirect----------	525	990	465	35	955
Total----------	5,760	10,860	5,100	365	10,495
TOTAL 1955-56 FLOODS					
Crops and pasture----	8,740	13,475	4,735	1,545	11,930
Flood-plain scour----	325	445	120	50	395
Other agricultural---	3,940	5,225	1,285	245	4,980
Nonagricultural------	3,435	4,815	1,380	50	4,765
Overbank deposition--	685	960	275	230	730
Indirect----------	1,645	2,400	755	195	2,205
Total----------	18,770	27,320	8,550	2,315	25,005

Table 9. - Effect of installed flood-prevention measures on area inundated by floods of 1956, Six Mile Creek Watershed, Ark.

Date of flood and depth of inundation	Estimates of area flooded		
	With no measures installed	With measures installed at time of flood 1/	Reduction because of installed measures
	Acres	Acres	Acres
February 16 to 17, 1956			
0-1.0 foot	2,480	1,890	590
1.1-3.0 feet	3,180	2,570	610
Over 3.0 feet	1,160	685	475
All depths	6,820	5,145	1,675
April 16, 1956 2/			
0-1.0 foot	870	775	95
1.1-3.0 feet	305	276	29
Over 3.0 feet	22	20	2
All depths	1,197	1,071	126
April 29, 1956 3/			
0-1.0 foot	830	55	775
1.0-3.0 feet	320	35	285
Over 3.0 feet	140	10	130
All depths	1,290	100	1,190

1/ 13 structures effective on Six Mile Creek and tributaries and 1 structure effective on Hurricane Creek tributary.
2/ Flooding occurred only on Hurricane Creek.
3/ Flooding occurred only on Six Mile Creek.

For the 2 years 1955 and 1956, flood-prevention measures installed produced a total benefit of $8,550 (table 8). An estimated total benefit of $25,005 would have resulted if the watershed program had been completed. The 1955-56 storms would have caused only $2,315 in floodwater and sediment damage if all planned measures had been installed.

In addition to the floodwater and sediment-reduction benefits, the flood-protection program is expected to bring about intensification of land use in the flood-plain area. Annual records of changes in land use and crop yields that are to be maintained while the evaluation study is underway will provide a measure of this land use enhancement benefit. Before the devastating flood

Table 10. - Floodwater and sediment damage and estimated benefits from installation of flood-prevention measures in 1956, Six Mile Creek Watershed, Ark.

Type of damage	Actual damage	Estimated damage without flood-prevention measures	Benefits from installed flood-prevention measures 1/	Estimated damage with all planned flood-prevention measures installed	Benefits from installation of all planned flood-prevention measures
	Dollars	Dollars	Dollars	Dollars	Dollars
FLOOD OF FEBRUARY 16 TO 17, 1956					
Crops and pasture----	1,955	2,905	950	190	2,715
Flood-plain scour----	25	35	10	0	35
Other agricultural---	940	1,700	760	45	1,655
Nonagricultural------	1,105	1,695	590	0	1,695
Overbank deposition--	10	15	5	0	15
Indirect----------	405	635	230	25	610
Total----------	4,440	6,985	2,545	260	6,725
FLOOD OF APRIL 16, 1956					
Crops and pasture----	855	955	100	95	860
Flood-plain scour----	10	10	0	0	10
Other agricultural---	90	105	15	0	105
Nonagricultural------	50	80	30	0	80
Overbank deposition--	5	5	0	0	5
Indirect----------	100	115	15	10	105
Total----------	1,110	1,270	160	105	1,165
FLOOD OF APRIL 29, 1956					
Crops and pasture----	190	2,325	2,135	0	2,325
Flood-plain scour----	0	30	30	0	30
Other agricultural---	0	0	0	0	0
Nonagricultural------	0	0	0	0	0
Overbank deposition--	0	10	10	0	10
Indirect----------	20	240	220	0	240
Total----------	210	2,605	2,395	0	2,605

1/ 14 floodwater-retarding structures were installed and operating.

of 1927, the Six Mile Creek flood plain was used for crops more intensively than at present. It can be expected that the watershed program will bring about some restoration of the flood plain to its former intensive use.

Changes in land use and cover conditions have not been sufficient to produce measurable effects on runoff or erosion. Therefore, no surveys have been made to date for the purpose of determining changes in soil cover complex in sample watersheds and drainage areas above the stream gages.

Monumented ranges and profiles of the ground surface were established on sites following construction so that deposition in these structures could be measured. Inspections following the storm of March 20, 1955, and in June 1956, revealed that only structure No. 6 had collected any appreciable amount of sediment. During the storm of March 20, 1955, the detention pool of structure No. 6 was filled within approximately 5 feet of the emergency spillway crest, and remained at this level for 2 days (fig. 11). Upstream from the structure where the main channel entered this stage of the detention pool, sediment accumulated to a depth of 3 inches on about an acre of land near the channel. The deposit thinned to less than one-half of an inch in thickness approximately 100 feet from the channel. As a result, sediment accumulation averaged 1 inch on some 4 acres of land.

At several valley cross-sections of Six Mile and Hurricane Creeks, inspections during the early winter of 1955 and early summer of 1956 indicated slight recovery in flood-plain scour in a few instances. This recovery was due not so much to a light deposition of silt, but to the fact that a reduction in flooding and a slightly improved, yet still below normal, growing season had permitted vegetation to become better established in the scoured areas.

LAND AND WATER UTILIZATION

Land in farms accounts for approximately 81 percent of the total land area in the watershed (table 11). The Ozark National Forest, administered by the United States Forest Service, includes 15,800 acres of mountainous land located in the Short Mountain Creek Subwatershed. Fort Chaffee, U. S. Department of the Army, includes 3,140 acres in Six Mile Creek Subwatershed. The remaining 4,576 acres of land not in farms are used for urban developments, roads, railroads, coal strip mines, and dumps.

Only slightly in excess of 10 percent of the land in farms, comprising a total of 133,641 acres, is cropland. About 7 percent of the land in farms is meadowland and 21 percent is improved open pasture. Unimproved open pasture and woodland pasture accounts for more than half of all land in farms. About 6 percent of the land in farms is classed as woodland.

Flood-Plain Lands

The benefits of the watershed program are expected to accrue largely on the farmlands through soil and water conservation, better utilization, and

Mud deposits one-half of an inch to 3 inches deep in upper part of flood pool of floodwater-retarding structure No. 6 following flood of March 20, 1955. (SCS neg. ARK-62170-A.)

Photograph of area above about 1 year later showing an excellent cover of bermuda grass. (SCS neg. ARK-62170-B.)

Table 11. - Major uses of land by subwatersheds, Six Mile Creek, Ark., 1954

Major land use	Six Mile Creek	Hurricane Creek	Short Mountain Creek	Total
	Acres	Acres	Acres	Acres
Land in farms	76,887	38,656	18,098	133,641
National forest 1/	80	0	22,848	22,928
Fort Chaffee	3,140	0	0	3,140
Coal mining	57	836	72	965
Lakes	0	0	342	342
Urban, roads, etc.	1,636	808	1,167	3,611
All uses	81,800	40,300	42,527	164,627

1/ Includes 7,200 acres of private land inside national forest boundary.

prevention of flood damages. The bulk of benefits of the structural measures will accrue on the flood-plain lands. For this reason detailed records are kept annually of changes in land use, crop and pasture yields, and flood and sediment damage on all flood-plain lands. As a base from which changes can be measured, a record of land use items was taken for each year in a 4-year period (1951-54) prior to the effective operation of the program.

Data on average use of flood-plain lands in the 1951-54 base period are presented in table 12. Ten percent of the flood plain of Six Mile Creek was used for crops in the base period. Only 2 percent of Hurricane Creek and 17 percent of the Short Mountain Creek flood plain were planted to crops. A third of the flood plain of these three main streams was used as meadow and improved pasture. Unimproved open pasture and woodland accounted for 42 percent of the flood-plain lands in the base period and was the predominat use of bottom lands in Six Mile Creek and Short Mountain Creek. Meadow and open pasture was the predominant use of the Hurricane Creek flood plain.

Annual records of land use in the flood plain for the years 1951 through 1956, show significant shifts in cropping patterns, but only minor shifts in or out of crop use (table 13). From 1951 through 1953, around 8 percent of the flood plain was available for crop use; this use increased to 10 percent in 1954 and 1955. In 1956, crops and idle cropland accounted for 13 percent of the flood plain.

Three-fourths of the flood plain is in capability classes I, II, and III land (table 14). Capability class V occupies 20 percent of the flood plain. The watershed program is expected to enhance the utilization of land in classes I, II, III, and V.

Abandoned field in Six Mile Creek flood plain. This field has been out of production for approximately 8 years because of frequent flooding and slow drainage. (SCS neg. ARK-62169.)

Field on Hurricane Creek flood plain taken out of cultivation because of frequent flooding. The owner intends to cultivate this bottom land after the floodwater-retarding structures are built. (SCS neg. ARK-62172.)

Table 12. - Average use of flood-plain lands, by subwatersheds, Six Mile Creek Watershed, Ark., 1951-54 base period

Land use	Subwatershed			Total flood plain
	Six Mile Creek	Hurricane Creek	Short Mountain Creek 1/	
	Acres	Acres	Acres	Acres
Oats	146	40	20	206
Cotton	35	0	35	70
Corn	327	29	54	410
Sorghum	52	2	16	70
Soybeans	69	0	64	133
Idle cropland	71	66	46	183
Meadow	583	325	122	1,030
Improved open pasture	1,307	1,448	365	3,120
Unimproved open pasture	2,206	438	338	2,982
Woodland pasture	1,075	1,026	101	2,202
Miscellaneous	693	379	0	1,072
Stream channels	543	152	106	801
Floodwater-retarding reservoirs and lakes	32	0	0	32
All uses	7,139	3,905	1,267	12,311
Double-cropped acreages	78	15	26	119

1/ Excludes original flood-plain area in Cove and City Lakes.
Field survey data.

Base crop and pasture yields are presented in tables 15, 16, and 17. Average yields for each of the three major subwatersheds indicate no significant difference (table 15). Yields are shown to be relatively low in the base period, partly because of drought (table 16). A slight improvement in yields is shown for 1955 and 1956. Expected differences in yields of crops and pastures by land-capability classes did not occur in the base period (table 17). Different types of soils, drought, and cultural practices are major factors that influence yields in the area.

Uplands

Only about 2 percent of the land in upland farms is used for crops (table 18). Another 7 percent is in meadowland. Open pastureland takes up more than half of the upland, and woodland pasture accounts for 40 percent of

Table 13. - Use of flood-plain lands, Six Mile Creek Watershed, Ark., 1951-56

Land use	1951	1952	1953	1954	1955	1956
	Acres	Acres	Acres	Acres	Acres	Acres
Oats	74	157	245	356	467	569
Cotton	32	39	113	96	68	62
Corn	462	450	367	367	275	276
Sorghum	27	37	39	182	190	392
Wheat	---	---	---	---	---	65
Peas	---	---	---	---	6	11
Sudan grass	---	---	---	---	---	86
Truck	---	---	---	---	29	---
Soybeans	136	128	158	112	25	54
Idle cropland	332	177	88	138	166	119
Meadow	965	953	1,123	1,087	681	614
Improved open pasture	3,257	3,018	3,229	2,984	3,285	3,164
Unimproved open pasture	2,875	3,114	2,903	3,044	2,762	2,604
Woodland pasture	2,054	2,146	2,146	2,466	2,649	2,889
Miscellaneous 1/	1,177	1,182	1,182	756	600	440
Stream channels	801	801	801	801	801	801
Floodwater-retarding reservoirs and lakes	0	0	0	127	287	379
Total	12,192	12,202	12,394	12,516	12,291	12,525
Double-cropped acreages	0	10	202	324	99	333

1/ Includes woodland not grazed.
Field survey data.

Table 14. - Average use of flood-plain lands by land-capability classes, Six Mile Creek Watershed, Ark., 1951-54 base period

Land use	Land-capability class							All classes 1/
	I	II	III	IV	V	VI	VII	
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Oats	36	112	24	---	---	---	---	172
Cotton	50	---	20	---	---	---	---	70
Corn	168	160	178	---	6	---	---	512
Sorghum	30	42	13	---	---	---	---	85
Peas	---	---	---	---	---	---	---	---
Truck	---	2	---	---	---	---	---	2
Soybeans	110	45	---	---	---	---	---	155
Idle cropland	30	41	38	---	22	---	---	131
Meadow	303	226	100	43	164	---	---	836
Improved open pasture	640	960	888	---	728	---	---	3,216
Unimproved open pasture	336	964	813	172	141	25	194	2,645
Woodland pasture	105	355	765	75	1,036	16	100	2,452
Total	1,808	2,907	2,839	290	2,097	41	294	10,276

1/ Excludes miscellaneous, stream channels, reservoir sites, and woodland not grazed.
Field survey data.

Table 15. - Crop and pasture yields by subwatersheds, flood plain, Six Mile Creek Watershed, Ark., 1951-54 base period

Land use	Unit	Subwatershed			All flood plain
		Six Mile Creek	Hurricane Creek	Short Mountain Creek	
Oats:					
Hay	Ton	2.9	1.5	1.2	2.3
Grain	Bushel	32.0	---	---	32
Cotton	Pound	322	---	428	375
Corn	Bushel	24	31	28	25
Sorghum	Ton	3.2	---	2.9	3.1
Truck	Dollar	---	---	---	200
Soybeans	Bushel	9.0	---	11.0	11
Soybean hay	Ton	1.4	---	---	1.4
Meadow	do.	1.1	1.0	1.2	1.1
Improved open pasture	AUM	1.1	1.8	1.34	1.5
Unimproved open pasture	do.	1.2	1.7	.9	1.2
Woodland pasture	do.	.4	.6	.4	.5

Field survey data.

Table 16. - Crop and pasture yields, flood plain, Six Mile Creek Watershed, Ark., 1951-56

Land use	Unit	1951	1952	1953	1954	1955	1956
Oats:							
Grain	Bushel	---	30	30	33	---	40
Hay	Ton	2.0	1.7	1.2	1.7	1.6	1.1
Silage	do.	---	---	---	---	---	4.0
Cotton	Pound	520	464	370	233	391	375
Corn:							
Grain	Bushel	36	26	20	18	31	26
Fodder	Ton	---	---	---	---	---	2.0
Silage	do.	---	---	---	---	---	3.0
Sorghum:							
Grain	Bushel	---	---	---	---	---	15
Fodder	Ton	4.1	3.2	3.7	2.8	3.0	2.4
Silage	do.	---	---	---	---	7.0	9.2
Soybeans	Bushel	26	11	11	4	15	12
Soybean hay	Ton	2.0	1.5	1.5	1.0	.8	.8
Meadow	do.	1.0	1.0	.8	.8	1.2	.9
Improved open pasture	AUM	1.6	1.5	1.4	1.4	1.9	1.9
Unimproved open pasture	do.	1.5	1.2	1.1	1.0	1.4	1.3
Woodland pasture	do.	.6	.6	.5	.5	.6	.6

Field survey data.

Table 17. - Crop and pasture yields by land-capability class, flood plain, Six Mile Watershed, Ark., 1951-56

Land use	Unit	Land use capability class							All classes
		I	II	III	IV	V	VI	VII	
Oats:									
Hay	Ton	1.1	1.6	1.2	---	1.0	---	---	1.3
Silage	do.	---	3.0	---	---	---	---	---	3.0
Grain	Bushel	26	19	---	---	---	---	---	25
Cotton	Pound	382	377	344	---	---	---	---	372
Corn:									
Fodder	Ton	---	---	2.0	---	---	---	---	2.0
Silage	do.	3.0	3.2	---	---	---	---	---	3.2
Grain	Bushel	32	24	26	---	17	---	---	28
Sorghum:									
Fodder	Ton	1.0	2.9	2.5	---	---	---	---	2.5
Silage	do.	7.2	7.1	4.7	---	11.3	---	---	7.4
Grain	Bushel	---	---	---	---	15	---	---	15
Soybeans	Bushel	12	---	---	---	---	---	---	12
Soybean hay	Ton	---	.8	---	---	1.5	---	---	.9
Meadow	do.	1.1	1.9	1.0	.9	1.1	---	---	1.2
Improved open pasture	AUM	1.7	1.9	1.6	1.5	2.3	---	---	1.8
Unimproved open pasture	do.	1.3	1.5	1.4	1.6	1.9	---	1.3	1.4
Woodland pasture	do.	.6	.7	.6	.4	.6	.8	.4	.6

Field survey data.

Table 18. - Major use of upland, Six Mile Creek Watershed, Ark., 1951-56

Land use	1951	1952	1953	1954	1955	1956
	Acres	Acres	Acres	Acres	Acres	Acres
Oats	972	1,372	1,773	1,943	1,822	1,579
Cotton	---	---	---	243	291	121
Corn	49	49	49	---	73	243
Sorghum	---	---	121	121	243	401
Soybeans	728	---	---	---	---	---
Millet	---	---	---	---	---	85
Idle	608	850	364	243	121	364
Meadow	8,258	8,259	9,109	9,109	10,809	7,773
Improved open pasture	35,827	35,706	35,342	34,977	36,192	36,920
Unimproved open pasture 1/	27,569	27,569	27,083	26,840	27,083	25,626
Woodland pasture 2/	47,438	47,644	47,608	47,973	44,815	48,337
Total	121,449	121,449	121,449	121,449	121,449	121,449

1/ Includes ungrazed open pasture.
2/ Includes nonproductive woodland.
Sample field data.

the upland use. Oats, sorghum, corn, and cotton are major crops. All upland crops are grown on land-capability classes I, II, and III (table 19). About three-fifths of the upland is in classes I, II, and III. Pastures and meadow are the chief uses of the better land classes. More than a third of land-capability class II is used for meadow.

Crop yields on uplands used for crops do not differ significantly from the yields on flood-plain lands (table 20). No discernible trend in yields is shown by the records obtained on sample fields for the years from 1951 to 1956. Yields of oats on uplands have averaged about 40 bushels per acre except in 1955, when the average yield was only 18 bushels per acre.

Pasture yields on land classes VI and VII are somewhat lower than on the better classes of land (table 21). All pastureland in the Six Mile Creek Watershed, especially woodland, is low in productivity.

Reservoir-Site Lands

The land required for the completed 23 floodwater-retarding structures totals 2,227 acres (table 22). Before construction, the average annual gross value of crop and pasture production on the land permanently inundated by sediment pools was $6,066 (1954 prices). The annual gross value of production from lands in the flood pool, prior to construction, averaged $3,664.

Table 19. - Average use of upland by land-capability classes, Six Mile Creek Watershed, Ark., 1951-54 base period

Land use	Land use capability class							All classes
	I	II	III	IV	V	VI	VII	
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Oats	49	704	644	---	---	---	---	1,397
Cotton	---	12	36	---	---	---	---	48
Corn	---	36	---	---	---	---	---	36
Sorghum	---	---	73	---	---	---	---	73
Soybeans	---	170	---	---	---	---	---	170
Meadow	---	6,680	2,271	36	---	---	---	8,987
Improved open pasture	668	8,368	21,508	2,611	---	---	1,324	34,479
Unimproved open pasture	668	2,818	19,250	3,413	---	838	668	27,655
Woodland pasture	---	753	6,425	4,821	2,077	1,907	32,621	48,604
Total	1,385	19,541	50,207	10,881	2,077	2,745	34,613	121,449

Sample field data.

Table 20. - Crop and pasture yields on upland, Six Mile Creek Watershed, Ark., 1951-56

Land use	Unit	1951	1952	1953	1954	1955	1956
Oats:							
Grain	Bushel	39	43	41	41	18	40
Hay	Ton	1.5	1.2	1.5	2.8	2.0	1.3
Cotton	Pound	---	---	---	250	375	---
Corn	Bushel	35	40	30	---	20	11
Sorghum	Ton	---	---	2.8	2.5	4.1	3.5
Millet	do.	---	---	---	---	---	.7
Meadow	do.	1.4	1.3	1.1	1.0	1.0	1.1
Improved open pasture	AUM	1.4	1.4	1.4	1.4	1.6	1.7
Unimproved open pasture	do.	1.0	.9	.9	.9	1.0	1.0
Woodland pasture	do.	.4	.3	.3	.3	.3	.3

Sample field data.

Table 21. - Crop and pasture yields on upland by land use capability class, Six Mile Creek Watershed, Ark., 1951-56

Land use	Unit	Land use capability class							All classes
		I	II	III	IV	V	VI	VII	
Oats									
Grain	Bushel	---	39	34	---	---	---	---	39
Hay	Ton	1.3	1.1	2.0	---	---	---	---	1.6
Cotton	Pound	---	500	156	---	---	---	---	271
Corn	Bushel	---	10	19	---	---	---	---	15
Sorghum	Ton	---	---	3.2	---	---	---	---	3.2
Millet	do.	---	---	.7	---	---	---	---	.7
Meadow	Ton	---	1.1	.9	1.0	---	---	---	1.1
Improved pasture	AUM	1.6	1.7	1.5	2.1	---	---	1.2	1.5
Unimproved pasture	do.	1.0	1.0	1.0	1.0	---	.7	.8	1.0
Woodland pasture	do.	---	.3	.3	.4	.3	.2	.3	.3

Sample field data.

Table 22. - Land use on sites of installed floodwater-retarding structures before construction, Six Mile Creek Watershed, Ark. 1/

Land use	Sediment pool	Flood pool	Structure	Spillway	All land
	Acres	Acres	Acres	Acres	Acres
Flood plain:					
Cropland	27	---	---	---	27
Meadow	35	---	---	---	35
Open pasture	321	---	---	---	321
Woodland pasture	46	---	---	---	46
Other	54	---	40	---	94
Total	483	---	40	---	523
Upland:					
Cropland	---	33	---	---	33
Meadow	---	24	---	---	24
Open pasture	---	1,084	---	---	1,084
Woodland pasture	---	417	---	---	417
Other	---	48	39	59	146
Total	---	1,606	39	59	1,704
Grand total	483	1,606	79	59	2,227

1/ Includes all structures, except numbers 15, 19, and 24.

In flood pools in which floods did not occur during 1955 and 1956, no reduction in value of production was noted. In flood-pool areas located on the tributaries where 1955 and 1956 floods occurred, the storms were not of sufficient magnitude to alter production from that prior to construction of the structures. In general, farmers have not as yet made any significant change in the use of land that is subject to periodic flooding.

The loss in production income from lands inundated by sediment pools has been partly offset by the value of services and products received from the stored water. Benefits subject to monetary evaluation include domestic water supply of $800 and irrigation of 6 acres of truck crops valued at $150 in terms of increased income. Other benefits received but not presently expressed in monetary terms include stockwater and recreation.

Water Utilization

The problem of water utilization and control in the Six Mile Creek Watershed is illustrated by figure 12, which shows annual rainfall for a 40-year period and by figure 13, which shows the seasonal variation of rainfall. In the last 40 years, annual rainfall has ranged from less than 30 to nearly 70 inches. From the standpoint of crop production, the extreme variation in monthly distribution of rainfall is even more important. These variations in rainfall affect crop yields and pasture-grazing capacities so greatly that the measurement of yield response resulting from soil conservation and watershed-treatment measures becomes difficult.

At the time the project was started on Six Mile Creek Watershed, 463 stock ponds had been constructed and 22 wells and springs had been developed for stock water. The water-storage capacity of these ponds is estimated to be not more than 232 acre-feet. Water is stored chiefly for livestock use. Probably not more than 8 or 10 ponds had sufficient storage capacity to provide a dependable source of water for irrigation.

As of December 31, 1956, there were 638 stock ponds in the watershed with a combined capacity of approximately 364 acre-feet of water. Farm ponds constructed during the last 3 years are larger, mainly because of the drought that has prevailed. The larger capacity provides better assurance of a continuous supply of stock water. The possibility of supplemental irrigation has also contributed to larger ponds. Some 18 to 20 ponds large enough to make some irrigation possible have been completed in the last year. The most important use of stored water in the area still is for livestock purposes.

The 23 floodwater-retarding structures that have been completed have 17,307 acre-feet of detention storage capacity and 2,322 acre-feet of sediment pool storage, or a total capacity of 19,629 acre-feet. The most beneficial use now made of water in the sediment pools is for livestock. Twenty additional farmers downstream from the floodwater-retarding structures are supplied an adequate and satisfactory source of stock water. To some of these farmers, water has been a problem because of lack of suitable pond sites, soil types, and inability to finance construction of structures from private sources.

A number of landowners with good bottom lands below the retarding structures are planning to use water from the sediment pools for irrigation. In 1955, one farmer irrigated 6 acres of watermelons from water in the sediment pool of structure No. 11. In 1956, another farmer bought sprinkler irrigation equipment and irrigated a late crop of oats. He plans eventually to irrigate 50 acres of bottom land and 15 acres of upland. Future plans include some supplemental irrigation below all except 3 or 4 of the structures.

During the severe drought of 1956, getting water for livestock became a serious problem. Normally, many farmers have a dependable supply of water from the deep holes in the smaller streams. In 1956, these holes dried up. Through the cooperation of the landowners on whose land the retarding structures are located and the sponsoring districts, the gate valves on sites 2, 4,

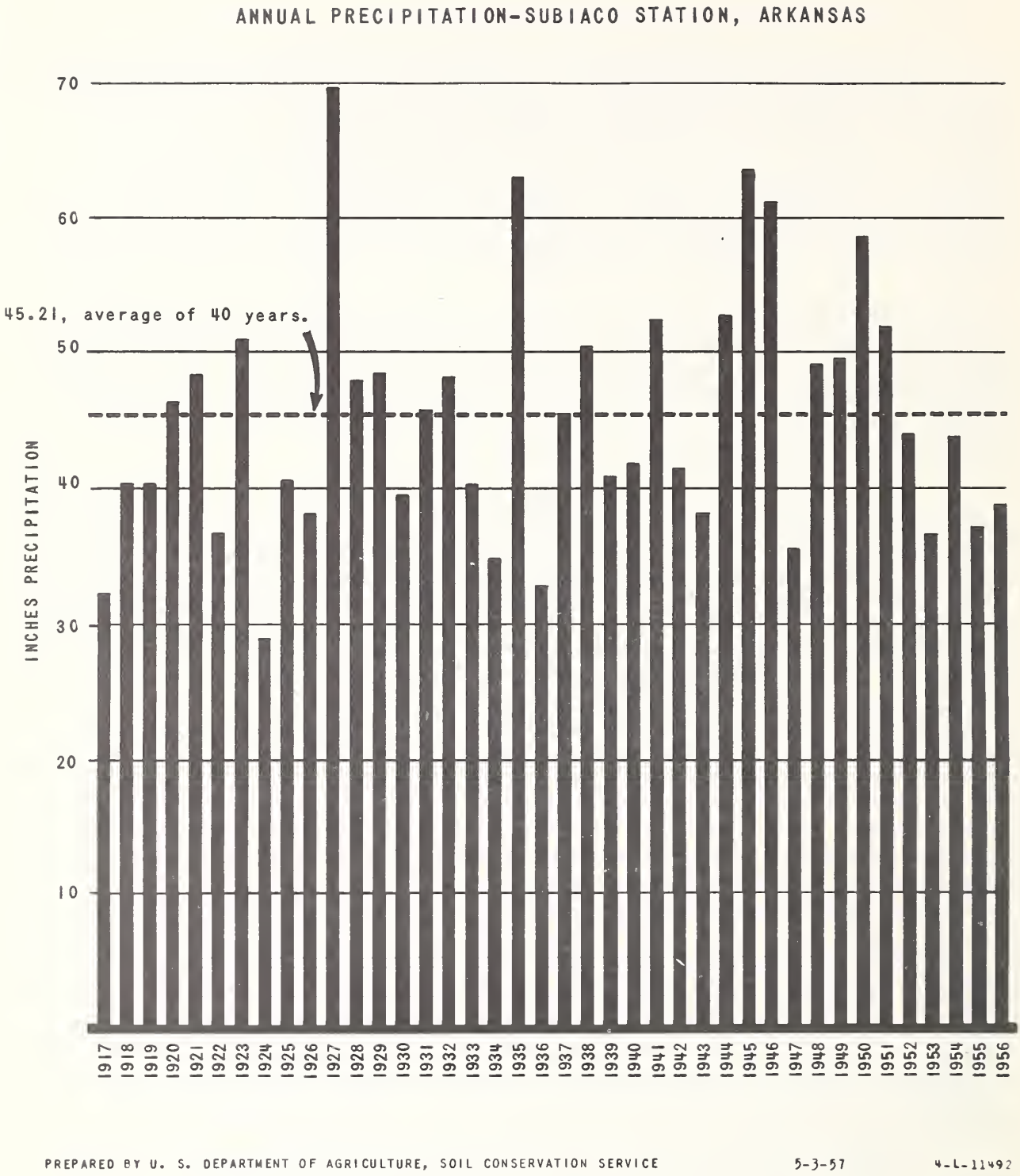
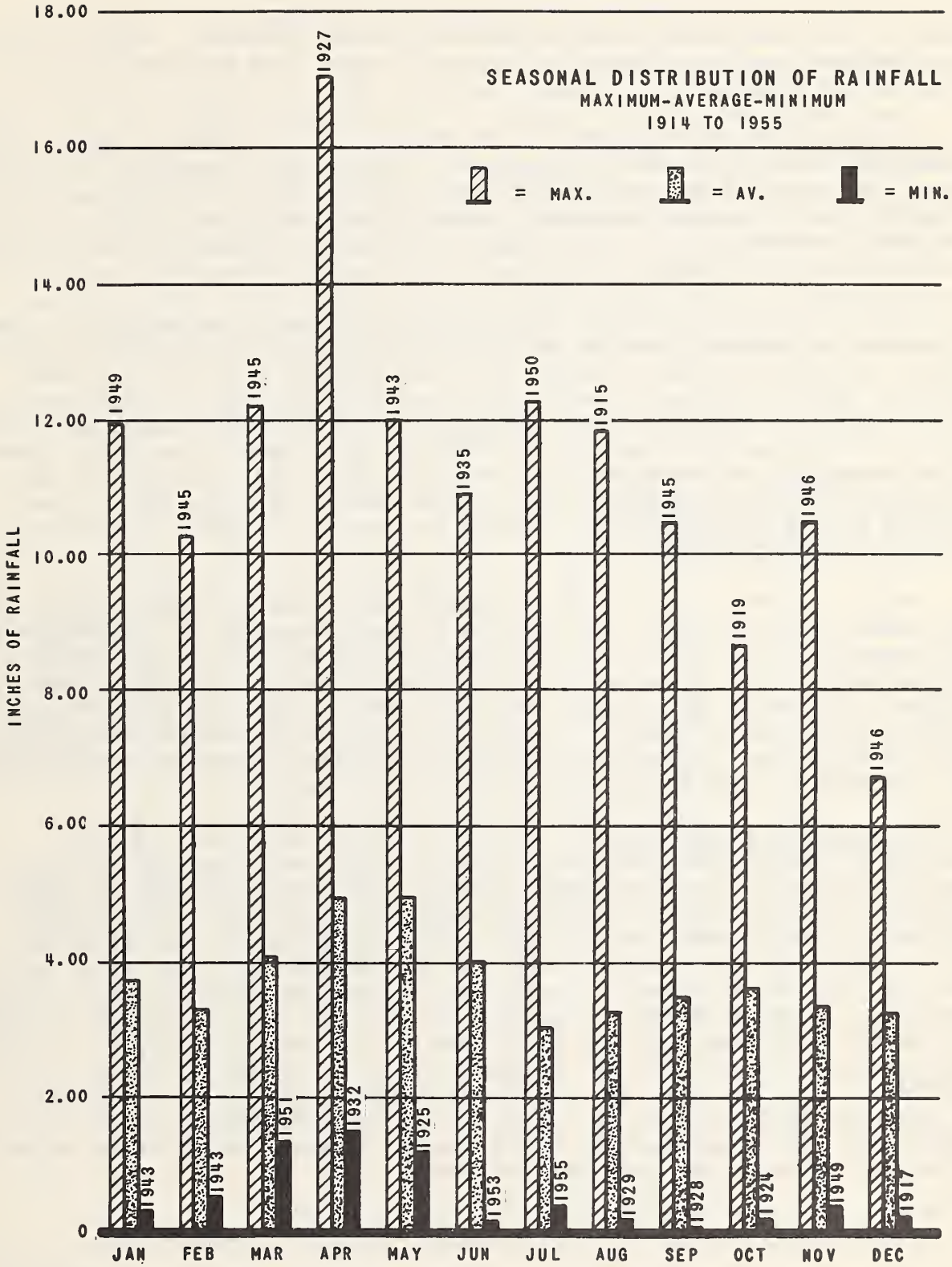

ANNUAL PRECIPITATION-SUBIACO STATION, ARKANSAS
45.21, average of 40 years.
INCHES PRECIPITATION
70
60
50
40
30
20
10
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
5-3-57
4-L-11492

Figure 12



DATA FROM SUBIACO WEATHER BUREAU STATION.

PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE 5-3-57 4-L-11493

Figure 13

5, 6, 9, 10, 12, and 23 were opened for periods ranging from 1 day up to 2 months to fill the stream channels below for use by livestock. About 20 livestock farmers were benefited by the release of water from the sediment pools of the retarding reservoirs.

Recreational facilities are planned for most of the pools and some 4 or 5 landowners already have them in operation. Three of the lakes have been used extensively by community groups, Girl Scouts, Boy Scouts, and other local organizations for picnics, swimming, camping trips, and other outings. All of the pools have been or are being stocked with fish, and fishing clubs have been organized on two of them.

The pool on site 7 has been made available through an agreement with the landowners as a secondary source of water for the city of Booneville. A supplementary agreement has been executed with the landowner of site 6 to provide water in times of shortage. The city has installed pumping and other facilities at site 7 at a cost of about $40,000. For these standby facilities, it is paying the landowners an annual rental of $800 for 20 years, the period covered by the agreement. No water has been used from these sites to date, but the availability of the supplemental supply made possible the location of a new industry in Booneville that employs about 200 people and has an annual payroll of approximately $500,000.

Paris, a city of about 4,000 population, has a municipal water system that gets water from City Lake. City Lake has a storage capacity of 2,400 acre-feet and a surface area of 190 acres. The towns of Subiaco, east of the watershed, and Charleston, west of the watershed, get their water supplies from reservoirs located just outside the drainage area of Six Mile Creek. The small villages of Chismville, Branch, Ratcliff, Caulkville, and Peter Pender have no community water supply works. Individual residences and business establishments in these small communities depend upon individual wells for water.

It should be remembered that benefits described above could not be expected to accrue in all watersheds and, normally, probably would not have been experienced in Six Mile Creek Watershed. The extreme drought has made supplemental water supplies of greater importance during the last few years than would normally have been the case. The acquisition of industry by the city of Booneville was a purely fortuitous circumstance that may not be duplicated in any other watershed. Finally, the sediment pools are designed solely for storage of sediment and are expected to fill with silt in 50 years. During that period their capacities for water storage will decline steadily. In some States, water laws are such that storage of water in sediment pools is not permitted. As a firm basis for evaluating benefits from the use of water in the sediment pools could not be established, these incidental benefits were not considered by the planning party in determining economic justification of the project set forth in the watershed work plan.

AGRICULTURAL ECONOMY OF WATERSHED

Farms in the Six Mile Creek Watershed are larger in acreage than the average farm in Arkansas (table 23). More farms are in the 41 to 80 acre size group than any other group (fig. 14). Six Mile Creek farms contain less cropland but more pasture and woodland. Accordingly, a relatively larger part of the farm income is obtained from livestock than from crops. In 1954, gross income per farm in the watershed was only 54 percent of the average farm income of the State. Most of the watershed farms are owner-operated. This is in contrast to the tenure situation in Arkansas as a whole, in which a third of all farms are tenant-operated and 13 percent are operated by part owners. In comparison with the economic area (delineation made by U. S. Bureau of the Census) within which the watershed is located, watershed farms are larger but the average value of total production per farm is about the same.

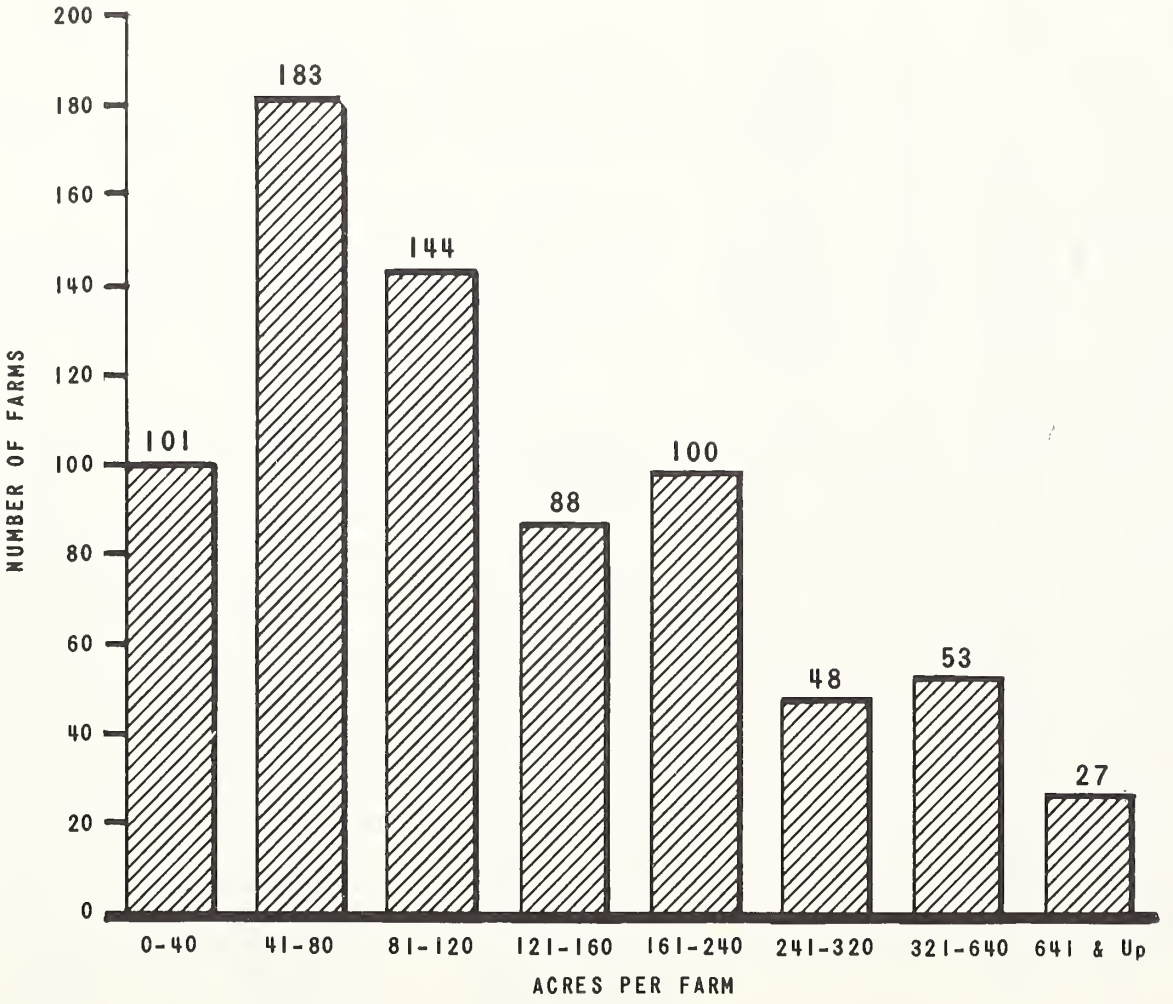
Table 23. - Comparative status of farm economy, Six Mile Creek Watershed, Ark., 1954

Item	Unit	Six Mile Creek Watershed	Economic area 2 1/	Arkansas
Use of land in farm (average per farm):				
Cropland:				
Harvested	Acre	29	23	38
Idle	do.	1	4	6
Open pasture	do.	80	58	30
Woodland pasture	do.	42	35	28
Woodland	do.	10	9	17
Other	do.	4	4	4
Total	do.	166	133	123
Tenure of operators:				
Owner-operator	Percent	97	70	53
Part owner	do.	2	17	13
Tenant-operator	do.	1	13	34
Value of total farm sales (average per farm)	Dollar	1,828	1,729	3,390
Source of farm income:				
Crop sales	do.	82	490	2,600
Livestock and livestock products, sales	do.	1,740	1,227	770
Other	do.	6	12	20

1/ Includes Crawford, Franklin, Johnson, Pope, Sebastian, Logan, and Yell Counties.

Base survey data and Census of Agriculture, 1954.

SIZE OF FARMS, SIX MILE CREEK WATERSHED, ARKANSAS-1954



PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE 5-3-57 4-L-11494

Figure 14

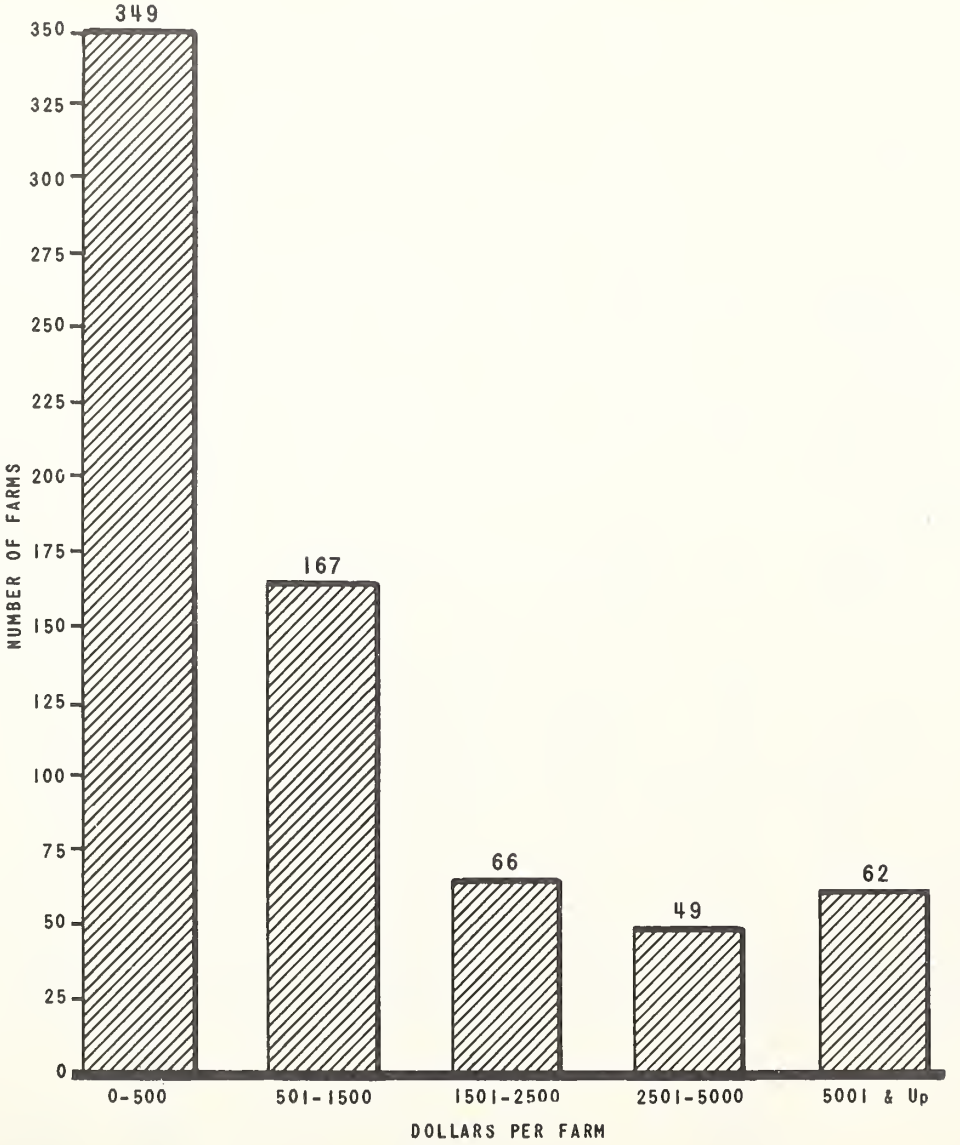
Less than a third of the watershed farms may be considered as full time; nearly half are part-time; and about one-fourth are either idle or of a subsistence type with negligible sales of farm products. About half of the farms have gross incomes of $500 per year or less (fig. 15). Average land use, livestock enterprises, and income of the 755 watershed farms included in the base survey are shown by types of farms in table 24. Although cropland

Table 24. - Economic characteristics of farms, Six Mile Creek Watershed, Ark., 1954

Item	Unit	Operated farms			Idle farms	All farms
		Full-time	Part-time	Subsistence		
Tenure of operator:						
Owner-operated	Number	231	334	58	122	745
Tenant-operated	do.	5	2	2	1	10
Total	do.	236	336	60	123	755
Average size of farm	Acre	198	174	77	115	165
Land use per farm:						
Crops	do.	50	28	6	1	29
Idle cropland	do.	1	1	1	1	1
Improved open pasture	do.	51	41	4	---	35
Unimproved open pasture	do.	46	46	35	38	45
Woodland pastured	do.	46	54	17	14	42
Woods not grazed	do.	---	---	---	59	10
Wasteland	do.	2	1	13	1	2
Miscellaneous	do.	---	1	---	---	1
Farmstead	do.	2	2	1	1	1
Livestock per farm:						
Cows milked	Number	14	11	---	---	12
Beef cattle	do.	29	27	---	---	27
Value of sales per farm:						
Crops	Dollar	143	83	7	---	82
Livestock	do.	557	641	2	---	460
Milk and butterfat	do.	1,733	1,335	3	---	1,136
Poultry	do.	202	180	2	---	144
Other	do.	17	---	---	---	6
Off-farm work:						
Farmers reporting	Number	59	336	55	---	450
Days per farm reporting	do.	13	252	96	---	201

Base survey of farms.

GROSS FARM INCOME, SIX MILE CREEK WATERSHED, ARKANSAS-1954



PREPARED BY U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE 5-3-57 4-L-11482

Figure 15

occupies 25 and 16 percent, respectively, of the land on full-time and part-time farms, the value of crops sold is low. Hay and oats account for about 97 percent of the cropland harvested. In the main, they are fed to livestock on the farms where they are grown. The average value of all sales per acre of cropland and open pastureland is $17.89 on full-time farms and $19.38 on part-time farms. These low incomes are supplemented by income obtained from off-farm employment. Off-farm employment is substantial on part-time farms where the average number of days worked off the farm is 252. Twenty-five percent of the full-time farm operators work off the farm but they worked an average of only 13 days on outside work. Operators of 92 percent of the subsistence farms work off the farm. They averaged nearly 100 days per farm.

Low farm income in the watershed is explained partly by the low intensity of land use on predominantly small units, coupled with small livestock enterprises. Tables 25 and 26 indicate the status of farms in respect to these factors. On full-time farms, 26 percent of the land is crop and meadow and 72 percent is pastured, while on part-time farms the corresponding use is 16 and 82 percent, respectively. These farms average about 3.5 acres of grazed land per head of cattle, including both beef and dairy stock. Value of sales of livestock and livestock products per milk cow and per beef animal are $122.72 and $21.39, respectively. Only 21 percent of the operated farms have incomes from farm sales in excess of $2,500 (table 27). These farms include about 41 percent of all farmland, account for 73 percent of all farm income, and average 343 acres in size.

Table 25. - Farms and farmland, by size of farm groups, Six Mile Creek Watershed, Ark., 1954 1/

Farm size (acreage intervals)	Farms	Percentage of all farms in size group	Percentage of all farmland in size group
	Number	Percent	Percent
40 or less	73	12	3
41-80	149	24	10
81-120	123	20	13
121-160	86	14	12
161-240	90	14	18
241-320	38	6	10
321-640	50	8	21
Over 640	13	2	13
Total	622	100	100

1/ Owner-operated farms, only.

Base survey data.

Table 26. - Use of land in farms, by type of farm, Six Mile Creek Watershed, Ark., 1954

Land use	Full-time		Part-time 1/		Subsistence 2/		Idle		All farms	
	Acres	Per-cent	Acres	Per-cent	Acres	Per-cent	Acres	Per-cent	Acres	Per-cent
Cropland:										
Used	7,476	14.9	6,271	9.9	207	4.2	14	0.1	13,968	10.4
Idle	146	.3	165	.3	43	.9	157	1.0	511	.4
Meadow	5,357	10.7	3,611	5.7	168	3.4	100	.7	9,236	6.9
Open pasture:										
Improved	12,939	25.8	14,949	23.6	263	5.3	18	.1	28,169	21.1
Unimproved	11,774	23.4	17,610	27.8	2,279	46.0	5,112	33.8	36,775	27.5
Woodland pasture	11,563	23.0	19,447	30.7	1,077	21.7	1,791	11.8	33,878	25.4
Woodland	---	---	7	3/	---	---	7,726	51.1	7,733	5.8
Wasteland	557	1.1	336	.5	843	17.0	118	.8	1,854	1.4
Farmstead	392	.8	570	.9	66	1.3	92	.6	1,120	.8
Miscellaneous	5	3/	380	.6	12	.2	---	---	397	.3
Total	50,209	100.0	63,346	100.0	4,958	100.0	15,128	100.0	133,641	100.0

1/ Farmers who worked 90 or more days per year off the farm, and whose chief source of income was off-farm work.
2/ Farmers who had less than $250 gross cash farm income and little income from off-farm work.
3/ Less than 0.05 percent.

Base survey data.

Table 27. - Farms and farmland by gross income classes, Six Mile Creek Watershed, Ark., 1954 1/

Gross income class	Farms	Percentage of all farms	Percentage of all farm income	Percentage of all farmland	Average size of farm
	Number	Percent	Percent	Percent	Acres
0-$500	227	36.5	2.1	22.2	109
$501-$1,500	195	31.4	14.7	26.0	148
$1,501-$2,500	68	10.9	10.2	11.1	181
$2,501-$5,000	58	9.3	16.8	17.2	330
Over $5,000	74	11.9	56.2	23.5	354
All classes	622	100.0	100.0	100.0	177

1/ Owner-operated farms, only.

Base survey data.

The low productivity of farmland, the small operating units, and the low farm incomes can be expected to retard full realization of benefits that otherwise might result from the watershed program. Opportunities for increasing farm income by conservation practices exist, but problems of financing improvements are evident.

Value of crop and pasture production in the sample areas during the base period 1951-54 and in 1956 is shown in tables 28 and 29. On these sample fields that

Table 28. - Value of crop and pasture production, Six Mile Creek Watershed, Ark., 1951-54 base period (1954 prices)

Crop	Flood plains		Drainage areas 2, 5, and 6 1/		Drainage areas 13 and 23 2/		Watershed sample	
	Dollars	Percent	Dollars	Percent	Dollars	Percent	Dollars	Percent
Hay--------	18,218	24.9	7,644	36.9	40,329	55.9	15,610	56.0
Oats-------	6,571	9.0	1,574	7.6	18,576	25.8	3,021	10.8
Cotton-----	8,087	11.0	---	---	481	.7	360	1.3
Corn-------	16,605	22.7	1,966	9.5	2,411	3.3	1,056	3.8
Sorghum----	5,368	7.3	1,261	6.1	733	1.0	258	.9
Truck------	---	---	780	3.8	669	.9	---	---
Soybeans---	4,606	6.3	---	---	3,156	4.4	---	---
Pasture----	13,784	18.8	7,473	36.1	5,733	8.0	7,585	27.2
Total--	73,239	100.0	20,698	100.0	72,088	100.0	27,890	100.0

1/ Ouachita Highlands drainage areas.
2/ Cherokee Prairie drainage areas.
Field survey data.

Table 29. - Value of crop and pasture production, Six Mile Creek Watershed, Ark., 1956 (1956 prices)

Crop	Flood plains		Drainage areas 2, 5, and 6 1/		Drainage areas 13 and 23 2/		Watershed sample	
	Dollars	Percent	Dollars	Percent	Dollars	Percent	Dollars	Percent
Hay--------	8,713	12.5	4,345	36.2	22,259	34.2	6,522	31.4
Oats-------	11,629	16.7	1,264	10.5	25,138	38.7	2,349	11.3
Cotton-----	8,326	12.0	---	---	8,645	13.3	---	---
Corn-------	5,535	7.9	182	1.5	891	1.4	219	1.0
Sorghum----	15,850	22.8	778	6.5	---	---	1,655	8.0
Soybeans---	1,190	1.7	---	---	25	0	---	---
Pasture----	18,365	26.4	5,445	45.3	8,076	12.4	10,025	48.3
Total--	69,608	100.0	12,014	100.0	65,034	100.0	20,770	100.0

1/ Ouachita Highlands drainage areas.
2/ Cherokee Prairie drainage areas.
Field survey data.

represent the watershed, the average value of production in 1956 was 26 percent lower than the average for 1951-54. These declines in value of production were due partly to changes in land use and to lower farm prices. In 1956, pasture and hay crops accounted for 81 percent of the value of all crop production in the Ouachita Highland drainages, 46 percent in the Cherokee Prairie drainages, and 38 percent in the flood plains. Oats, corn, and sorghum crops in 1956 made up 19 percent of the value of all crop production in the Ouachita Highlands, 39 percent in the Cherokee Prairie, and 48 percent in the flood plains. These relative values of crop production represent increases over the base period except for the Highlands, where production of oats, corn, and sorghum decreased 5 percent. Production of cotton is important only in the Cherokee Prairie and flood-plain areas where it comprised about 12 percent of the value of all crop production in 1956.

Value of crop and meadow production (excluding pasture) on all flood plains from 1951 to 1956 averaged more than $60,000, of which 65 percent occurred in the subwatershed of Six Mile Creek, 25 percent in Short Mountain Creek, and 10 percent in Hurricane Creek (table 30). In general, the value of production in terms of 1954 price levels shown in table 28 increased on the flood plains of Six Mile Creek and Hurricane Creek, and decreased on Short Mountain Creek. The variation in value of production by years cannot be traced to floods, but results from local droughts and other factors.

Table 30. - Value of crop and meadow production on flood-plain lands, Six Mile Creek Watershed, Ark., 1951-56 (1954 prices)

Year	Six Mile Creek	Hurricane Creek	Short Mountain Creek	Total
	Dollars	Dollars	Dollars	Dollars
1951	32,443	4,175	24,783	61,401
1952	32,582	4,135	16,931	53,648
1953	35,601	8,075	16,326	60,002
1954	43,608	7,345	11,721	62,674
1955	50,301	3,952	11,182	65,435
1956	38,383	7,187	11,468	57,038
Total	232,918	34,869	92,411	360,198
1951-56 average	38,820	5,811	15,402	60,033

Field survey data.

PLANS FOR CONTINUATION OF EVALUATION

No changes in the plan of evaluation previously outlined are contemplated. Future evaluation activities will involve more complete coverage of the watershed as more program measures are installed. As additional annual records of crop and pasture field uses, production, and management are obtained, classification and analysis of data will permit appraisal of program effects.

APPENDIX

Tables 31 to 36 contain selected additional data that illustrate the range of yields by soil capability classes and soil unit groups included in the intensive study areas.

Table 31. - Land use in intensive study areas, Six Mile Creek Watershed, Ark., 1951-54 base period

Item	Flood plain	Sample drainage area- 2	5	6	13	23	Sample fields 1/
	Number	Number	Number	Number	Number	Number	Number
Fields	371	69	38	56	122	85	205
	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Cropland	2/ 1,867	87	74	283	620	1,833	604
Pastureland	8,020	3,296	764	2,232	1,998	1,841	6,020
Woodland 3/	1,074	433	602	18	129	55	548
Idle cropland	184	14	5	78	73	44	31
Total 4/	11,012	3,830	1,445	2,611	2,820	3,773	7,203

1/ Located every square mile in watershed, except flood plain and Short Mountain Creek Subwatershed.
2/ Includes 133 acres double-cropped land.
3/ Includes miscellaneous and wasteland.
4/ Excludes 1,180 acres of stream channel and reservoirs.

Table 32. - Average crop and pasture yields, intensive study areas, Six Mile Creek Watershed, Ark., 1951-54 base period

Land use	Unit	Flood plain	Sample drainage area - 2	5	6	13	23	Sample fields 1/
Oats:								
Grain	Bushel	32	50	---	34	44	37	42
Hay	Ton	2.3	1.1	1.0	1.7	1.1	---	1.6
Cotton	Pound	375	---	---	---	119	160	250
Corn:								
Grain	Bushel	22	---	25	28	19	34	35
Silage	Ton	10	---	---	8.7	---	---	---
Fodder	do.	---	---	---	---	.8	---	---
Sorghum, fodder	do.	3.1	2.0	---	---	---	1.3	2.6
Truck	Dollar	200	250	35	---	165	---	---
Soybeans	Bushel	11	---	---	---	---	24	---
Soybean hay	Ton	1.4	---	---	1.2	1.3	---	---
Meadow	do.	1.1	.9	1.0	.9	1.2	1.5	1.2
Improved open pasture	AUM	1.5	1.6	1.6	1.4	1.2	1.5	1.2
Unimproved open pasture	do.	1.2	1.0	.3	.9	1.9	1.3	.9
Woodland pasture	do.	.5	.6	.2	.1	.3	.4	.3

1/ Located every square mile in watershed, except flood plain and Short Mountain Creek Subwatershed.

Table 33. - Land use capability class of lands, intensive study areas, Six Mile Creek Watershed, Ark.

Capability class	Flood plain 1/	Sample drainage area 2/ - 2	5	6	13	23	Sample fields 3/
	Acres	Acres	Acres	Acres	Acres	Acres	Acres
I	1,808	7	---	---	24	3	83
II	2,907	---	10	20	576	846	1,159
III	2,839	573	349	858	1,739	1,871	2,977
IV	290	411	---	180	155	703	645
V	2,097	---	---	---	47	143	123
VI	41	---	---	404	82	113	163
VII	294	2,494	963	1,278	298	111	2,053

1/ Does not include wasteland and woodland not grazed.

2/ Includes parts of some fields extending beyond the limits of drainage area boundary.

3/ Located every square mile in watershed, except flood plain and Short Mountain Creek Subwatershed.

Table 34. - Yields of meadow by land use capability classes, intensive study areas, Six Mile Creek Watershed, Ark., 1951-54 base period

Capability class	Flood plain	Sample drainage area - 2	5	6	13	23	Sample fields 1/
	Tons	Tons	Tons	Tons	Tons	Tons	Tons
I	1.1	0.8	---	---	1.1	---	---
II	2.0	.9	1.0	---	1.2	1.2	1.2
III	1.2	---	.9	.9	1.2	1.3	.8
IV	.9	---	---	1.1	.5	1.0	1.3
V	1.3	---	---	---	---	---	---
VI	---	---	---	---	---	---	---
VII	---	---	1.1	---	---	1.0	---

1/ Located every square mile in watershed, except flood plain and Short Mountain Creek Subwatershed.

Table 35. - Number of acres of each soil unit in intensive study areas, Six Mile Creek Watershed, Ark.

Soil unit 1/	Flood plain	Sample drainage area - 2	5	6	13	23	Sample fields 2/
	Acres	Acres	Acres	Acres	Acres	Acres	Acres
3a	68	---	---	---	---	---	8
5	---	---	---	---	194	2,141	881
5a	45	---	---	---	86	477	---
5al	11	---	---	---	82	---	263
6	798	---	89	571	1,164	278	1,736
6a	103	---	---	88	31	279	126
6al	214	---	52	11	17	---	154
6b	30	---	---	---	---	---	---
6c	---	449	---	---	---	---	126
6d	---	165	70	6	4	---	50
6bx	8	---	---	---	---	---	---
6x	6	---	---	---	---	---	---
7	549	---	---	339	227	138	467
7al	---	---	---	---	63	---	---
7b	127	---	---	---	---	---	---
7c	9	53	---	---	---	---	---
7d	338	---	10	87	---	---	90
8	1,541	---	---	---	---	---	55
8a	1,654	12	---	33	---	---	132
8ab	664	---	---	---	---	---	---
8al	1,038	---	---	---	---	---	143
8b	1,209	3	---	---	20	159	---
8d	66	---	---	---	---	---	---
9	1,106	7	---	---	---	---	200
9b	494	---	---	---	---	---	---
9d	71	---	---	---	---	---	---
9db	28	---	---	---	---	---	---
19	---	---	---	---	---	96	---
19a	---	---	---	---	3	---	---
19c	57	499	218	154	37	---	522
19d	128	264	---	247	---	---	155
20	50	---	---	---	2	22	178
20c	42	1,400	74	755	5	---	720
20d	84	408	98	40	535	---	530
25	---	---	---	---	55	---	40
25c	---	4	---	---	71	39	46
27	---	61	92	60	68	74	436
27c	---	---	---	---	23	---	40

1/ Soil unit descriptions are as follows:

3 - Deep, fine-textured, very slowly permeable bottomland soils
5 - Deep, medium-textured, very slowly permeable soils
6 - Deep, medium-textured, slowly permeable soils
7 - Deep, medium-textured, moderately permeable soils
8 - Deep, medium-textured, slowly permeable bottomland soils
9 - Deep, medium-textured, moderately permeable bottomland soils
19 - Shallow, medium-textured, very slowly permeable soils
20 - Shallow, medium-textured, moderately permeable soils
25 - Very shallow, medium-textured soils
27 - Rough broken or rough stony land, noncalcareous material

Descriptions of subgroups of these units are:

a - Moderately wet
al- Slightly wet
b - Frequent damaging overflows
c - Stony soils
d - Gravelly soils
x - Mounds

2/ Located every square mile in watershed, except flood plain and Short Mountain Creek Subwatershed.

Table 36. - Yields of meadow on soil units in intensive study areas, Six Mile Creek Watershed, Ark., 1951-54 base period

Soil unit	Flood plain	Sample drainage areas					Sample fields 1/
		2	5	6	13	23	
	Tons	Tons	Tons	Tons	Tons	Tons	Tons
5	---	---	---	---	1.1	1.1	1.2
5a	---	---	---	---	1.0	1.5	---
5al	1.0	---	---	---	---	---	---
6	1.3	---	.9	1.1	1.0	1.2	1.3
6a	.8	---	---	1.1	1.4	1.5	.8
6al	---	---	1.0	---	1.8	---	---
6b	1.5	---	---	---	---	---	---
6d	---	---	1.1	---	---	---	---
6x	.8	---	---	---	---	---	---
7	.7	---	---	.9	---	---	---
7al	---	---	---	---	1.3	---	---
7b	1.2	---	---	---	---	---	---
7d	1.0	---	---	---	---	---	---
8	1.5	---	---	---	---	---	---
8a	.9	1.1	---	1.1	---	---	.8
8al	.9	---	---	---	---	---	1.5
8b	1.5	.2	---	---	---	---	.7
9	1.0	.8	---	---	---	---	---
9b	3.0	---	---	---	---	---	---
19d	---	1.2	---	.8	---	---	---
20	---	---	---	---	---	.7	---
20d	---	---	---	---	---	---	.5

1/ Located every square mile in watershed, except flood plain and Short Mountain Creek subwatershed.